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SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey
U.S. Department of the Interior

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The Secretary of the Interior has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 30, 1988.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several services of the Water Resources Scientific Information Center. The cumulative SWRA file from 1968 and monthly updates are available also in magnetic tape through lease from NTIS.

THE WATER RESOURCES SCIENTIFIC INFORMATION CENTER DOES NOT PROVIDE COPIES OF DOCUMENTS ABSTRACTED IN THIS JOURNAL. Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

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Please use the edge index on the back cover to locate Subject Fields and Indexes.

01 NATURE OF WATER

Includes the following Groups: Properties; Aqueous Solutions and Suspensions.

02 WATER CYCLE

Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

04 WATER QUANTITY MANAGEMENT AND CONTROL

Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION

Includes the following Groups: Identification of Pollutants; Sources of Pollution; Effects of Pollution; Waste Treatment Processes; Ultimate Disposal of Wastes; Water Treatment and Quality Alteration; Water Quality Control.

06 WATER RESOURCES PLANNING

Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

07 RESOURCES DATA

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08 ENGINEERING WORKS

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SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

2A. General

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Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5A.
W88-01059

MATERIAL LOADING TO DEGRAY LAKE, ARKANSAS: PATTERNS AMONG VARIABLES AND SIGNIFICANCE OF STORM EVENT LOADING,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W88-01061

TWO-DIMENSIONAL MODELING OF STORM EVENT INFLOW PROCESSES AT DEGRAY LAKE,
Ford, Thornton, Norton and Associates Ltd., Little Rock, AR.
M. C. Johnson, and D. E. Ford.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 565-600, 18 fig, 16 ref.

Descriptors: *Model studies, *Reservoirs, *Limnology, *DeGray Lake, *Arkansas, *Storm runoff, *LARM, *Laterally Averaged Reservoir Model, Nutrients, Bacteria, Storms, Suspended sediment, Mathematical models, Hydrographs, Computer models.

Storm flows contribute large amounts of nutrients, bacteria, and suspended sediment to a reservoir. Often these flows enter the pool as density currents which are difficult to analyze because of their unsteady and three-dimensional nature. The two-dimensional reservoir hydrodynamic model LARM (Laterally Averaged Reservoir Model) was used to analyze inflow processes following a storm event at DeGray Lake, Arkansas. Examined were the dilution, mixing, travel times, and placement of four water quality constituent plumes. Since each constituent loaded at different times during the inflow hydrography, differences in transport were observed. LARM was able to correctly predict inflow placement, travel times, and dilutions of each constituent plume. (See also W88-01056) (Author's abstract)
W88-01079

EFFECTS OF CARBONATE GEOLOGY ON URBAN RUNOFF,
Tennessee Valley Authority, Norris.
For primary bibliographic entry see Field 4C.
W88-01137

INTERNATIONAL SYMPOSIUM ON HYDROMETEOROLOGY.
American Water Resources Association, Bethesda, MD.
For primary bibliographic entry see Field 2B.
W88-01203

RUNOFF CURVE NUMBER ESTIMATION USING REMOTE SENSING TECHNIQUES,
Morrison-Knudsen Co., Inc., Boise, ID.
For primary bibliographic entry see Field 7B.
W88-01213

RELATIONSHIP OF ANTECEDENT FLOW RATE TO STORM HYDROGRAPH COMPONENTS,
Pennsylvania State Univ., University Park. School of Forest Resources.
For primary bibliographic entry see Field 2G.
W88-01215

MEASURED EVAPORATION IN HIGH RAINFALL AREAS, LEEWARD KOOLAU RANGE, OAHU, HAWAII,
Hawaii Univ. at Manoa, Honolulu. Water Resources Research Center.
For primary bibliographic entry see Field 2D.
W88-01217

CALIBRATING A WATERSHED ON DEEP GLACIAL TILL,
Wisconsin Univ.-Stevens Point. Coll. of Natural Resources.
N. E. Spangenberg.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 91-94, 3 fig, 2 tab, 6 ref.

Descriptors: *Hydrometeorology, *Calibrations, *Rainfall-runoff relationships, *Runoff forecasting, Glacial tills, *Little Plover River, *Wisconsin, Watersheds, Flow discharge, Flood peak, Annual variation, Precipitation, Hydrologic data.

The Little Plover River Watershed, located on a deep glacial till in central Wisconsin, shares calibration problems with watersheds in similar environments. Efforts to develop reasonable calibration equations included the use of climatic data and discharge from other basins. The best calibration for annual flows seems to involve the use of precipitation data logged four months to account for flow through the glacial mantle. Low flows and annual peak flows were also calibrated with the same values from nearby streams. No outstanding calibration equations were developed. It was concluded that calibration of watersheds developed on glacial deposits is still an annoying problem for the watershed scientist attempting to develop baseline data in glacial landscapes. (See also W88-01203) (Author's abstract)
W88-01218

COMPARATIVE ANALYSIS OF VARIOUS RAINFALL-RUNOFF MODELS,
Interamerican Center for Integral Development of Land and Water Resources, Merida (Venezuela).
R. A. Smith, and R. A. Amisial.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 101-104, 1 fig, 2 tab, 20 ref.

Descriptors: *Comparison studies, *Rainfall-runoff relationships, *Model studies, *Hydrometeorology, *Hydrologic models, *Potomac River, Linear models, Nonlinear models, Mathematical models, Simulation analysis.

Rainfall-runoff models are classified as Parametric and Black Box (linear and nonlinear) models. At the same time the models in each of these categories are classified as generalization models, in which rainfall-runoff data are necessary for parameter estimation, and regionalization models, where this kind of data is not necessary. Several models, covering all the spectrum for the Black Box Generalization models, were implemented. These models were used to simulate the rainfall-runoff process for the Potomac River near Cumberland, Maryland. An analysis was then made between all the models using a wide variety of fitting criteria. The results are presented in tabular and graphical form and the following conclusions are drawn: (1) The least squares in matrix form, the Laguerre functions, the Fourier transform, and the unit weight functions are superior unit hydrograph estimation techniques than the other truly linear techniques; (2) In the optimal linear techniques group, search procedure, linear programming, and the use of time series produced the best results; (3) The optimal linear techniques showed more consistency and produced better results than the truly linear techniques; and (5) Although all the optimal linear techniques mentioned above produced almost identical results, the use of search procedures without constraints is recommended due to its simplicity and flexibility. This technique has been criticized because it does not guarantee realizable results (non-negative unit hydrograph ordinates and unit volume unit hydrograph). In all the storms this condition occurred naturally with this technique. (See also W88-01203) (Lantz-PTT)
W88-01220

STATISTICAL FLOW FORECASTING MODEL FOR SMALL CATCHMENTS,
Clemson Univ., SC. Dept. of Civil Engineering.
S. Nnaji.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 105-109, 3 fig, 2 tab, 2 ref.

Descriptors: *Hydrologic models, *Model studies, *Hydrometeorology, *Forecasting, *Catchment areas, *Statistical studies, *Flow patterns, Flow profiles, Statistical analysis, Distributed Lag model, Statistical model, Rainfall-runoff relationships, Regression analysis.

The Distributed Lag model was adopted for adaptive flow forecasting within small catchments. The explanatory variables include the current and past values of rainfall intensity obtained, for example, from digitized weather data. Rainfall measurement errors are not considered in this effort in which the dependent variable is the flow rate at a location within the catchment. Model parameter estimates were obtained by Ordinary Ridge Regression on the first differences of the original variables. The use of first differences reduces serial dependence in the residuals while ridge regression enables one to select a stable set of parameter estimates. The model was calibrated with observed data. It was validated, in a forecast mode, using the estimated parameters and data sets different from those used in the calibration. (See also W88-01203) (Author's abstract)
W88-01221

TEST OF RAINFALL-RUNOFF MODELS AS ELEMENTS OF FLOOD FORECASTING MODELS FOR BIG RIVERS,
For primary bibliographic entry see Field 2E.
W88-01222

FORECASTING SNOWMELT RUNOFF,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2C.
W88-01236

USE OF WEATHER TYPES FOR MEDIUM RANGE RUNOFF FORECASTING,
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
A. A. Griend.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 241-256, 11 fig, 5 tab, 20 ref.

Descriptors: *Runoff forecasting, *Hydrometeorology, *Weather, *Runoff, *Forecasting, Regression analysis, Mathematical analysis, Statistical analysis, Hydrology, Meteorology, Climates.

As a basis for describing the dynamic character of the climate of the European Alpine environment, the Swiss meteorologist Prof. Dr. Max Schuepp developed a classification system of weather types. On the basis of this classification a selection of hydrometeorologically relevant classes of weather types has been made as a reference basis to investigate the relations between circulation types and runoff phenomena of an Alpine glaciated catchment. To bridge the gap between methods for short range (up to a few days) and long range forecasting of runoff a few weeks up to months), the usefulness of weather types has been evaluated for purposes of medium range runoff forecasting. Therefore a weather type based model has been developed for forecasting mean runoff for medium range periods of 10 days, to link on to the advance by the 'European Centre for Medium Range Weather Forecasts (ECMWF)' in Reading, England. By doing this an impulse is given to a new form of integration between the disciplines of hy-

drology and meteorology, leading to a weather type based approach to runoff forecasting. The model is based on a multiple regression analysis between the dependent variable runoff and a group of independent variables. The latter are split into initial variables, related to catchment conditions known at the date of forecast and future variables which can be extracted directly from forecast weather charts (direct method) or determined by translation of forecast weather charts into weather types (translation method). The combination of direct method variables and translation method variables lead to a combined method. The analyses have been performed for the Alpine catchment of the river Ahr (Northern Italy), which has a pluvio-nivo-glacial runoff regime. The analyses are based on the 23-year period (1953-1975). (See also W88-01203) (Author's abstract)
W88-01241

TRENDS AND EXTREMES OF LAKE ERIE WATER SUPPLIES,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 2H.
W88-01244

APPLICATION OF STATISTICAL LOW FLOW ANALYSIS AS A BASIS FOR WATER QUALITY PLANNING,
Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.
H. Rubach.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 293-298, 9 fig, 4 ref.

Descriptors: *Hydrometeorology, *Reservoir operation, *Water quality, *Duration analysis, *Runoff forecasting, *Statistical lowflow analysis, *Water quality management, *Statistical studies, *Runoff, Flow augmentation, Low flow, Mathematical studies.

Relations between runoff and water quality were analyzed on a statistical basis. Relevant investigations were made possible because, for the first time, parallel measurements of runoff and water quality parameters are available. Both relations between runoff and water quality and methods for improvement of water quality by low flow augmentation are discussed. If a proper threshold value for runoff augmentation and an essential water quality improvement are defined, the storage volumes must be assessed, which are necessary to produce this augmentation. During the analysis of the duration-runoff frequency function the mean flow of periods with defined durations has been used, the mean runoff which is necessary for the augmentation can be assessed directly as difference runoff. The necessary storage volume can be found by multiplying the difference runoff by the duration. If for instance in a period of 7 days a threshold value of runoff of 17.4 cu m/sec is to be produced, a volume of (17.4 - 13.5) x 7 x 86400 = 2,400,000 cu m is necessary. The found storage volume guarantees the augmentation of a 7-day low flow period with a return period of 2 years. It is assumed, in this case, that runoff control is possible in such a way that such a constant runoff threshold can be held. (See also W88-01203) (Lantz-PTT)
W88-01249

CLIMATIC VARIABILITY AND HYDROLOGIC PROCESSES: AN ASSESSMENT FOR THE SOUTHWESTERN UNITED STATES,
Arizona Univ., Tucson. Lab. of Tree-Ring Research.
C. W. Stockton, and W. R. Boggess.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 317-320, 10 ref. NSF Grant No. ATM 79-24365.

Descriptors: *Hydrometeorology, *Environmental effects, *Water yield forecasting, *Waste demand, *Climatic variability, *Hydrologic processes, *Hydrometeorology, *Rio Grande, *Colorado River, River basins, Air temperature, Runoff, Precipitation, Water supply.

Based on the likely upward trend in global temperatures, due to increasing amounts of man-induced atmospheric carbon dioxide, the possible effects of a warmer and drier climate on surface water supplies in the Rio Grande and Colorado River basins has been investigated. Should average annual temperatures increase by 2 C and precipitation decrease by 10%, annual runoff from the upper Rio Grande would likely decrease by about 30%. Decrease for the Colorado would be about 35% in the Upper and 50% in the Lower basins, respectively. Since demand is already exceeding or approaching supplies in these regions, any dimunition in water yield would have serious regional and national ramifications. (See also W88-01203) (Author's abstract)
W88-01253

DROUGHT HISTORY IN THE WESTERN GREAT PLAINS FROM TREE RINGS,
Arizona Univ., Tucson. Lab. of Tree-Ring Research.
D. M. Meko.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 321-326, 6 fig, 1 tab, 10 ref. NSF Grant No. ATM 7924365.

Descriptors: *Hydrometeorology, *Paleohydrology, *Drought, *Great Plains, *Tree rings, *History, Water supply, Water shortage, Regression analysis, Linear regression, Water management, Precipitation.

Drought history in the western Great Plains was reconstructed from 1640 to the present from recently collected tree-ring samples. Seven outlier ponderosa pine sites, comprising more than 100 trees, were sampled in the summer of 1980 in North Dakota, South Dakota, Nebraska, Montana, and Wyoming. Equations to reconstruct annual (September-August) precipitation were estimated by multiple linear regression of divisionally averaged precipitation against indices of ring width. Reconstructions emphasized the long-term significance of the 1930's drought: the years 1936, 1939, and 1934 ranked 1, 4, and 14, respectively, in drought severity out of 338 years. On the other hand, when drought conditions were averaged over periods 10 or more years, the 1930's drought paled in comparison with major droughts in the 1750's, 1820's, and 1860's. Spectral analysis indicated that the apparent 20-year return period of major drought in modern times is not a feature of the long-term drought history. A strong (95-99% significance level) spectral peak was found, however, at near 60 years. Water use planning should consider the possibility of long wavelength precipitation fluccuations that may not be discernible in the relatively short gaged records. (See also W88-01203) (Author's abstract)
W88-01254

PROBABILITY OF DROUGHT COVERAGE WITH VARIOUS RETURN PERIODS FOR JAPAN,
Tsukuba Univ. (Japan). Inst. of Geoscience.
N. Tase.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 327-331, 6 fig, 7 ref. Ministry of Education and Science Grant No. 56790166.

Descriptors: *Hydrometeorology, *Streamflow forecasting, *Drought, *Probability distribution, *Statistical analysis, *Japan, Rainfall, Streamflow, Precipitation, Water shortage, Water supply, Frequency distribution.

Probabilities of droughts have been analyzed as a point process of rainfall or stream flow. Discussed here are how large droughts with various return periods cover the area. That is, conditional probabilities of drought coverage once given that drought with a certain return period occurs are obtained from data analysis. Data used here are annual precipitation values at 82 stations in Japan for 50 years (1921-1970), which can be assumed to be normally distributed. After standardizing annual precipitation amounts, isolines of return periods of 2, 10, 20, 50, 100, 200, and 500 years are drawn for the 50 years, and drought area, number and area of drought cells are measured. The characteristics of drought occurrence are discussed and probabilities are obtained from frequency distributions. (See also W88-01203) (Author's abstract)
W88-01255

MEASURING DROUGHT SEVERITY AND ASSESSING IMPACT,
Nebraska Univ.-Lincoln. Center for Agricultural Meteorology and Climatology.
D. A. Wilhite.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 333-335, 11 ref.

Descriptors: *Hydrometeorology, *Drought severity, *Social impact, *Ecological effect, *Climatic variation, Palmer index, Economic aspects, Water shortage, Water resources management, Palmer Drought Severity Index, Drought.

Sensitivity to variations in climate is increasing in response to world population pressures and diminishing natural resources. The impact of the droughts of the mid-1970s and early 1980s is recent evidence of this sensitivity. In the U.S. annual losses due to drought are estimated to be approximately $1.2 billion. As a result, decision makers at all levels are experiencing an expanding need for accurate, near real-time information about droughts and their effects. The Palmer Drought Severity Index (PDSI) has been widely used as a general measure of water conditions. This index is based on a hydrologic accounting system which produces an index of zero under normal weather conditions for all climatic regimes. However, the PDSI is not infallible. In fact, the reliability of this index for many applications has become increasingly suspect. Shortcomings of the PDSI are reviewed. Some alternative approaches to the characterization of drought severity and impact. (See also W88-01203) (Author's abstract)
W88-01256

SCALE PROBLEMS IN THE SYNTHESIS OF MULTI-SITE PRECIPITATION,
For primary bibliographic entry see Field 2B.
W88-01262

INFLUENCES OF WEATHER PATTERNS ON WETLAND FLOODINGS,
Louisiana State Univ., Baton Rouge. Dept. of Marine Science.
For primary bibliographic entry see Field 2L.
W88-01263

2B. Precipitation

INTERNATIONAL SYMPOSIUM ON HYDROMETEOROLOGY.
American Water Resources Association, Bethesda, MD.
June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. 598 p. Edited by A. Ivan Johnson and Robert A. Clark.

Descriptors: *Hydrometeorology, *Symposium, *Data acquisition, Meteorology, Hydrology, Model studies, Measuring instruments, Precipitation, Forecasting, Weather modification, Acid rain, Water supply, Drought.

The fields of hydrology and meteorology have become increasingly interdisciplinary. Close working relations between two major divisions of science have become more and more necessary, resulting in the field of hydrometeorology. The International Symposium on Hydrometeorology was organized by AWRA to provide information on the current state-of-the-art and to discuss future directions in hydrometeorology. The papers in this

Proceedings volume provide background material for the many applications of hydrometeorology by both meteorologists and engineers. They illustrate the diverse interests of the several participating societies and of the numerous scientists from the Federal, state, university, and private sectors. The volume is organized into sections that deal with various program areas related to hydrometeorology: instrumentation and data acquisition, hydrologic modeling and forecasting, water supply and water resources, long-term planning for water quality, drought and climate, weather modification, acid rain, and probable maximum precipitation and frequency for design. (See W88-01204 thru W88-01296) (Lantz-PTT)
W88-01203

HYDROMETEOROLOGICAL SIGNIFICANCE OF RIME ICE DEPOSITS ON TREES IN THE COLORADO ROCKIES,
Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
E. E. Hindman, R. D. Borys, and P. J. DeMott.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 95-99, 3 fig, 1 tab, 8 ref. NSF Grant ATM 8109590.

Descriptors: *Hydrometeorology, *Rime ice, *Colorado, *Rocky Mountains, *Snow accumulations, Snowfall, Clouds, Precipitation rates, Icing, Snowpack.

Observations and measurements were made in liquid water clouds during snowfall periods at mountain top sites in the Colorado Rockies during the winter of 1981-1982. Liquid clouds were observed to occur frequently during snowfall periods at most sites. On the average, the rime rates were measured to be ten times the precipitation rates. The rime deposits were estimated to contribute 4-11% to the water content of the snowpack and to contribute up to 55% to the trace element composition of the snowpack. (See also W88-01203) (Author's abstract)
W88-01219

LOCALIZED QPFS - A STATUS REPORT,
National Weather Service, Fort Worth, TX. Southern Region.
H. M. Mogil.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 117-119, 2 fig, 7 ref.

Descriptors: *Precipitation forecasting, *Hydrometeorology, *Forecasting, *Quantitative studies, *Precipitation, *Weather forecasting, Flood forecasting, National Weather Service.

During the past five years the Lubbock Weather Service Forecast Office has developed and refined localized quantitative precipitation forecast (QPF) procedures for west Texas. Due to the success of their activities, the concept is being studied by other NWS Forecast Offices in Texas, Oklahoma, Arkansas, and Louisiana. The status of these projects and future plans to tie them together into a multi-state QPF program are summarized. (See also W88-01203) (Author's abstract)
W88-01223

SATELLITE TECHNIQUE FOR ESTIMATING RAINFALL FROM FLASH FLOOD PRODUCING THUNDERSTORMS,
National Earth Satellite Service, Washington, DC.
R. A. Scofield.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 121-128, 13 fig, 2 tab, 6 ref.

Descriptors: *Remote sensing, *Precipitation forecasting, *Hydrometeorology, *Satellite technology, *Rainfall, *Flash floods, *Thunderstorms, Rainfall intensity, Infrared imagery.

A technique has been developed that gives half-hourly or hourly rainfall estimates from convective systems by using GOES thermal infrared and high resolution visible pictures. This technique, called the Scofield/Oliver technique, is in the form of a decision tree, which a meteorologist uses to determine point or areal rainfall estimates, and is applied using imagery displayed with a digital enhancement curve. During the past year, an experimental modification to the Scofield/Oliver technique was developed for estimating rainfall from warm topped thunderstorms. This application was a good example of how the technique was used to help meteorologists and hydrologists locate areas of heavy rainfall in western Georgia and eastern Alabama for the issuance of flash flood warnings and to evaluate flood potential. Features to look for in the conventional and satellite data, which are often associated with warm IR top heavy rainfall events, are also presented. Additional areas for improvement are: (1) estimating rainfall from thunderstorms in dry environments or with high bases; and (2) locating areas of heavy thunderstorm rainfall using IR imagery. (See also W88-01203) (Lantz-PTT)
W88-01224

FORECASTING CONVECTIVE PRECIPITATION BY TRACKING CLOUD TOPS IN GOES IMAGERY,
National Earth Satellite Service, Washington, DC.
J. F. Moses.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 129-137, 8 fig, 10 ref.

Descriptors: *Hydrometeorology, *Forecasting, *Satellite technology, *Remote sensing, *Convective precipitation, Rainfall intensity, Computers, Thunderstorms.

Satellite meteorologists at the National Earth Satellite Service (NESS) have successfully used Geostationary Operational Environmental Satellite (GOES) imagery to locate and estimate half-hourly precipitation accumulations. Interactive processing techniques help meteorologists provide site-specific estimates within 30 minutes of the observation. Methods are presented which help satellite meteorologists provide a forecast based on tracks of convective cloud tops in GOES imagery. Experience has shown that the propagation of outflow boundaries is often consistent over several hours when convective activity is supported by a moist, unstable atmosphere. A 'normal persistance' method of forecasting was used to extrapolate the position and intensity of the convective activity resulting from an outflow boundary. Automatic precipitation estimates and convective cloud-top tracks were displayed on an interactive computer for an intense rainstorm on July 30, 1979. The speed and direction of thunderstorm outflow boundaries were determined and the point of intersection was predicted. The automatic precipitation estimates and man-machine interactive estimates compared favorably to rainfall reports from the dense automatic rain gage network operated by the Illinois State Water Survey. (See also W88-01203) (Author's abstract)
W88-01225

ESTIMATING RAINFALL USING SATELLITE IMAGERY FOR WARM-TOP THUNDERSTORMS EMBEDDED IN A SYNOPTIC-SCALE CYCLONIC CIRCULATION,
National Earth Satellite Service, Washington, DC.
L. E. Spayd.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 139-146, 12 fig, 2 tab, 4 ref.

Descriptors: *Hydrometeorology, *Precipitation forecasting, *Rainfall, *Satellite technology, *Thunderstorms, *Cyclones, Flash floods, Forecasting, Cyclonic precipitation, Rainfall intensity, Vorticity.

Several case studies of flash flood producing warm-top thunderstorms embedded in synoptic-scale cyclonic circulations which are easily recognized in the satellite imagery are summarized. These synoptic-scale cyclonic circulations are associated with a strong vorticity center at 500 mb and the warm-top thunderstorms occurred north of the 850 mb and surface low centers. The warm-top thunderstorms embedded in these weather systems, once recognized, can be used to make operational rainfall estimates. The estimates are made from consecutive visible and infrared satellite imagery using the Scofield/Oliver convective technique modified to accomodate thunderstorms with tops warmer than -62 C. (See also W88-01203) (Author's abstract)
W88-01226

OBJECTIVE ANALYSIS OF RAINFALL DATA FROM DIGITAL RADAR AND RAIN GAGE MEASUREMENTS,
National Weather Service, Silver Spring, MD. Office of Hydrology.
For primary bibliographic entry see Field 7B.
W88-01227

STRUCTURE OF HOMOGENEOUS ANISTROPIC CORRELATION FUNCTIONS FOR REAL-TIME RADAR RAINFALL ESTIMATION,
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W88-01228

RAINFALL RELATED PROBLEMS IN OPERATING THE GARD FLOOD WARNING SYSTEM,
Institut National Polytechnique de Grenoble (France).
For primary bibliographic entry see Field 2E.
W88-01229

GATLINBURG, TENNESSEE, FLASH FLOOD WARNING AND EVACUATION SYSTEM,
Tennessee Valley Authority, Knoxville. Floodplain Management Branch.
For primary bibliographic entry see Field 2E.
W88-01230

FLOOD FORECASTING/WARNING SYSTEM FOR IBADAN, NIGERIA,
Ibadan Univ. (Nigeria). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W88-01231

HYDROMETEOROLOGY OF A MAJOR FLOOD IN SOUTH AFRICA,
Stellenbosch Univ. (South Africa). Dept. of Geography.
W. A. Nieman.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 193-200, 7 fig, 17 ref.

Descriptors: *Hydrometeorology, *Floods, *South Africa, *Rainfall, *Rainfall-runoff relationships, *Flash floods, Vorticity, Rainfall intensity, Runoff, Flood plains, Precipitation.

The climate of Southern Africa south of 22 S and west of 25 E is semiarid to arid, with an annual precipitation of < 500 mm. Summer rains are convectional and very localized, causing minor flash floods that peak rapidly and recede quickly. On occasion, however, a westerly wave with exceptional amplitude may cut off a cold low from its source region, resulting in pronounced meridional flow. A blocking high over the Indian Ocean can then cause confluence of warm northerly and easterly air streams, and as cyclonic vorticity in the lower troposphere increases, maximum divergence at all levels will produce heavy rainfall to the east of the cutoff low. This happened in January 1982 over the central Karroo. Runoff from the almost circular catchment of the upper Buffels River converged on a pocket floodplain where the town of Laingsburg is situated upstream from the narrow gap in a ridge through which the flood, peaking at

an estimated 6,000 cu m/sec, had to flow. Streets running parallel to the river front acted as subsidiary channels, cutting off escape routes to higher land. More than 100 lives (out of a total population of 3,200) were lost and 300 of the town's 367 houses and business premises were severely damaged. (See also W88-01203) (Author's abstract)
W88-01233

FORECASTING DAILY PRECIPITATION OCCURRENCES WITH MARKOV CHAIN OF SEASONAL ORDER,
National Technical Univ., Athens (Greece). Dept. of Civil Engineering.
M. Mimikou.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 219-224, 2 fig, 2 tab, 8 ref.

Descriptors: *Hydrometeorology, *Markov process, *Precipitation forecasting, *Rainfall forecasting, *Forecasting, *Precipitation, *Markov chain, Seasonal variation, Statistical studies, Mathematical studies, Storms.

Forecasting daily precipitation occurrences is very important for planning and management of water resources. It is shown that the proper selection on a seasonal basis of the order of a Markov chain significantly improves its efficiency for forecasting daily precipitation occurrences. The average seasonal storm duration, being the average seasonal ratio of the number of wet days to the number of storm events and containing all meteorological and geographical information found by other researchers as well to influence the seasonally varying order of conditional dependence of daily precipitation occurrences, is proposed as a criterion for determining the proper seasonal Markov order. This thesis, though needing further investigation, is significantly supported in this paper. For seven precipitation stations in Greece, the forecasting error is minimized with chains of varying order, which, on a monthly basis, is the closest positive integer to the average storm duration in days reduced by one. There is a prevalence of orders higher than 1 in wet and of orders 1 or 0 in dry periods. The appearance at each station of the period with orders higher than 1 is delayed and its duration decreases going eastwards and with decreasing altitude. (See also W88-01203) (Author's abstract)
W88-01237

ECONOMIC IMPACT OF CLIMATE ON WATER RESOURCES MANAGEMENT,
Oklahoma Climatological Survey, Norman.
For primary bibliographic entry see Field 6C.
W88-01238

EXPERIMENTAL WATER SUPPLY FORECASTS BASED ON SEASONAL PRECIPITATION FORECASTS,
California State Dept. of Water Resources, Sacramento.
For primary bibliographic entry see Field 3B.
W88-01240

DROUGHT HISTORY IN THE WESTERN GREAT PLAINS FROM TREE RINGS,
Arizona Univ., Tucson. Lab. of Tree-Ring Research.
For primary bibliographic entry see Field 2A.
W88-01254

PROBABILITY OF DROUGHT COVERAGE WITH VARIOUS RETURN PERIODS FOR JAPAN,
Tsukuba Univ. (Japan). Inst. of Geoscience.
For primary bibliographic entry see Field 2A.
W88-01255

SCALE PROBLEMS IN THE SYNTHESIS OF MULTI-SITE PRECIPITATION,
K. M. Leytham.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 367-372, 6 fig, 3 tab, 6 ref. OWRT Project Nos. A-107-WASH and A-115-WASH.

Descriptors: *Hydrometeorology, *Model studies, *Precipitation forecasting, *Precipitation, *Rainfall distribution, *Stochastic hydrology, Atmospheric physics, Drought, Linear analysis, Model studies, Hydrologic models.

Consideration of the qualitative relationships between precipitation and atmospheric circulation over the west coast of North America suggests that inter-station precipitation relationships are nonlinear with higher cross correlations during drought than during normal or wet periods. This indicates that current multi-site stochastic models, which all assume linear inter-station relationships, may underestimate the aereal extent of severe drought. The presence of nonlinear inter-station relationships is confirmed by analysis of monthly precipitation data. Evaluation of the performance of a simple multi-site stochastic model shows that current methods may seriously distort spatial drought characteristics in the synthesis of data at widely separated sites (separation $>$ 1000 km). (See also W88-01203) (Author's abstract)
W88-01262

INTERNATIONAL ASPECTS OF ACID DEPOSITION,
North Carolina State Univ., Raleigh. School of Forest Resources.
For primary bibliographic entry see Field 5C.
W88-01272

GAS PHASE AND PRECIPITATION ACIDITIES IN THE COLORADO MOUNTAINS,
Colorado Coll., Colorado Springs.
For primary bibliographic entry see Field 5B.
W88-01274

SPATIAL AND TEMPORAL TRENDS IN THE CHEMISTRY OF ATMOSPHERIC DEPOSITION IN NEW ENGLAND,
Maine Univ. at Orono. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5B.
W88-01275

ACID PRECIPITATION AND BUFFER CAPACITY OF LAKES IN THE SIERRA NEVADA, CALIFORNIA,
California Univ., Santa Barbara. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5B.
W88-01277

ACID PRECIPITATION: THE IMPACT ON TWO HEADWATER STREAMS IN SHENADOAH NATIONAL PARK, VIRGINIA,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5C.
W88-01278

IMPACT OF ATMOSPHERIC DEPOSITION ON THE WATER QUALITY OF EVERGLADES NATIONAL PARK,
Everglades National Park, Homestead, FL.
For primary bibliographic entry see Field 5C.
W88-01279

RED SPRUCE DIEBACK IN VERMONT AND NEW HAMPSHIRE: IS ACID PRECIPITATION A CONTRIBUTING STRESS,
Pennsylvania Univ., Philadelphia. Dept. of Geology.
For primary bibliographic entry see Field 5C.
W88-01280

EFFECTS OF AMBIENT CONCENTRATIONS OF AIR POLLUTANTS ON VEGETATION INDIGENOUS TO THE BLUE RIDGE MOUNTAINS OF VIRGINIA,
Pennsylvania State Univ., University Park. Dept. of Plant Pathology.
For primary bibliographic entry see Field 5C.
W88-01281

OVERVIEW APPLICATION OF HMR 51-52 AND SITE-SPECIFIC STORM TRANSPOSITION AND MAXIMIZATION TECHNIQUE,
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
D. T. Jensen.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 547-551, 3 fig, 1 tab, 5 ref.

Descriptors: *Precipitation, *Probable maximum precipitation, *Storms, *Nebraska, *Hydrometeorology, *Flood forecasting, *Depth-area-duration analysis, *Box Butte Dam, Rainfall intensity, Storm transposition.

A 1,208-sq mi basin and a 638-sq mi basin above Box Butte Dam, Nebraska, were used as test cases for computing probable maximum precipitation (PMP). Noting new definitions for storm and basin PMP, Hydrometeorological Report numbers 51 and 52 (HMR 51-52) procedures are applied to the test basins. Traditional storm transposition and maximization assumptions are also considered. Nine critical storms from the Box Butte Dam region are transposed to the test basins and are maximized for moisture charge. Depth-durational aspects of the storms are presented. Comparisons of PMP estimates are made for the test cases using HMR 51-52 and traditional transposition and maximization techniques. Results show most differences in PMP estimates are within the reasonable range of measurable error. (See also W88-01203) (Author's abstract)
W88-01289

DRAINAGE CLIMATOLOGY FOR CALIFORNIA,
California State Dept. of Water Resources, Sacramento.
J. D. Goodridge.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 577-584, 6 fig, 3 ref.

Descriptors: *Hydrometeorology, *Drainage, *Climatology, *California, *Rainfall, *Depth-area-duration analysis, *Rainfall-runoff relationships, *Probable maximum precipitation, Precipitation, Rainfall intensity, Rainfall distribution, Frequency analysis, Statistical studies.

Spillway and culvert sizing in California are commonly based on precipitation for various return periods and storm durations. Rainfall records are used because design storms based on runoff records are highly variable. Discussed are two sets of extreme annual precipitation dat, which were compiled for drainage studies. The first is for 700 recording rain gages with 16,000 station years of annual series data for durations ranging from 5 minutes to 24 hours. The second set is for 1700 non-recording rain gages with 41,000 station years of annual series data for durations ranging from 1 to 60 days. A regional frequency analysis was performed on each data set. The method used to select a frequency distribution is by a comparison of the skew and kurtosis of the data sets. The main concept of this paper is the method of regionalizing the standard deviation. (See also W88-01203) (Author's abstract)
W88-01294

2-MINUTE RAINFALL EXTREMES,
Agricultural Research Service, Beltsville, MD. Hydrology Lab.
D. M. Hershfield.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 585-588, 5 fig, 2 tab, 9 ref.

Descriptors: *Hydrometeorology, *Probable maximum precipitation, *Statistical analysis, *Depth-area-duration analysis, *Rainfall, *Maps, *Data collections, Data interpretation, Rainfall intensity, Precipitation.

The analysis of extreme-value rainfall data is rarely extended to durations less than five minutes even though there are many applications for these durations in hydrology and agriculture. The general absence of readily available data for the very short duration is the primary reason for this shortcoming. Breakpoint rainfall data from 32 stations at 11 agricultural watersheds for durations of 2-min to 60-min served as the basis for this study. Relationships were established between the 2-min and longer duration ata which were then used as an aid in constructing several generalized maps for the eastern United States, including a 2-year 2-min map. Unlike the extreme-value analyses of 60-min and 24-hr data, the variability of the annual maximum 2-min values, as determined by the coefficient of variation for the individual stations, exhibits an irregular geographical pattern. (See also W88-01203) (Author's abstract)
W88-01295

SOME CHARACTERISTICS OF DAILY SUMMER MONSOON RAINFALL OVER INDIA, SUITABLE FOR HYDROLOGICAL PURPOSES,
Indian Inst. of Tropical Meteorology, Poona.
S. V. Singh, and R. H. Kripalani.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 589-596, 5 fig, 2 tab, 13 ref.

Descriptors: *Hydrometeorology, *Rainfall, *Monsoon, *India, *Hydrologic data, *Statistical studies, *Rainfall intensity, Hydrologic studies, Markov process, Rainfall distribution, Data interpretation, Data collections, Precipitation, Autoregressive methods, Model studies.

For several hydrological routine operations like flood forecasting, reservoir regulation, etc., climatological knowledge/forecast of exact quantities of rainfall are required. Apart from the usual climatological information, it is important to know the present state of the rainfall process because the rainfall, up to time scale of at least 1 day, is found to be dependent on its past. Studied here was the dependence in daily rainfall of 12 stations and in daily rainfall of 10 meteorological regions during the summer monsoon by: (1) analyzing the rainfall as stochastic point process by fitting several types of models like logmodel, Markov chains of order 1 and 2 to station data; and (2) fitting autoregressive and autoregressive moving average models to spatially averaged data. The significant conclusion is that the Markov chain of order 1 fits the runs of wet spells and autoregressive model order 1 fits the spatially averaged data satisfactorily. Further examination of rainfall intensities for spells of various length has revealed that rain intensity is more on spells of 2 or 3 days than on isolated days. These findings will have significant values in simulation of synthetic models of rainfall-runoff process. (See also W88-01203) (Author's abstract)
W88-01296

2C. Snow, Ice, and Frost

HYDROMETEOROLOGICAL SIGNIFICANCE OF RIME ICE DEPOSITS ON TREES IN THE COLORADO ROCKIES,
Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
For primary bibliographic entry see Field 2B.
W88-01219

FORECASTING SNOWMELT RUNOFF,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
G. Q. Tabios, and J. D. Salas.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 213-217, 2 tab, 12 ref. NSF Grant No. CEE-8110782.

Descriptors: *Hydrometeorology, *Forecasting, *Snowmelt, *Runoff, *Runoff forecasting, *Statistical analysis, Regression analysis, Seasonal runoff, Kalman filter, Statistical methods.

Various forecasting techniques for snowmelt runoff have been proposed in the literature. Most of them are of the multiple regression type where the total seasonal runoff is a function of several variables such as antecedent precipitation, snowcourse data, previous seasonal runoff and temperature. Among those noted in particular are the forecasting models developed by Ford (1959), subsequently improved by the USBR (1968) and that proposed by Tangborn and Rasmussen (1976). Some limitations of the forecasting techniques based on multiple regression analysis are discussed. In an attempt to improve such techniques, areal averaging by spatial interpolation and recursive model parameter estimation via Kalman filtering are introduced. The original and modified forecasting schemes were compared. The results showed that some improvements can be obtained by the suggested modifications. (See also W88-01203) (Author's abstract)
W88-01236

2D. Evaporation and Transpiration

EVAPORATION TIME SERIES ANALYSIS FOR MILFORD LAKE IN KANSAS,
Illinois State Water Survey Div., Champaign.
H. V. Knapp, Y.-S. Yu, and E. C. Pogge.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 79-83, 4 fig, 4 tab, 9 ref. Dept. of Int. Project No. B-053-KAN.

Descriptors: *Evaporation, *Time series analysis, *Milford Lake, *Kansas, *Hydrometeorology, Annual variation, Mathematical models, Fourier analysis, Mass transfer, Sensitivity analysis.

A weekly evaporation time series generated by the mass transfer method for the Milford Lake displays a predominant annual cycle with low evaporation in spring and winter and high evaporation in summer and fall. A mathematical model for the time series was developed. The model consists of a mean weekly component represented by a Fourier approximation and a stationary random residue by an autoregressive model. The frequency distribution is obtained from the synthetic evaporation series. On the average, the total evaporation for the four months from June through September exceeds 50% of the mean annual evaporation. An analysis of the weekly evaporation series led to a mathematical model which includes a mean weekly component represented by a Fourier approximation and a stationary random residue by an autoregressive model. The estimated evaporation is shown to be most sensitive to changes in water temperature. (See also W88-01203) (Lantz-PTT)
W88-01216

MEASURED EVAPORATION IN HIGH RAINFALL AREAS, LEEWARD KOOLAU RANGE, OAHU, HAWAII,
Hawaii Univ. at Manoa, Honolulu. Water Resources Research Center.
P. C. Ekern.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 85-90, 4 tab, 29 ref. DOE Project No. 1897.

Descriptors: *Evaporation, *Oahu, *Hawaii, *Leeward Koolau Range, *Hydrometeorology, *Rainfall, Tropical regions.

Small evaporimeters for high rainfall areas required a factor of 0.55 for conversion to California-grass water use. Elevated Class A pan evaporation was 0.63 and surface pan evaporation 0.54 evaporimeter water loss. Evaporimeter and meteorological parameters were measured along a 14 km transect in central Oahu to the 7,620 mm rainfall zone at 610 m, and along a 6.5 km transect in southern Oahu to the 4,191 mm rainfall zone at 153 m on the leeward slopes of the Koolau Range. Monthly evaporation was highly correlated with r-squared values of 0.663 to 0.936 between sites beneath the cloud base, but with only r-squared of 0.02 with the highest site frequently within the cloud. Daily evaporation correlation with sunlight over a 12-month period for the sites had r-squared values between 0.55 to 0.84. Priestly-Taylor alpha was nearly 2 for the dry Holmes site. Values of alpha were 10% more than 1.26 for the wet valley sites and 10% less than 1.26 on the ridges when net radiation was calculated from long wave radiation with an unimpeded sky. Clear sky net long wave radiation was 20% greater in the valley than on the ridge. Runoff was 22%, evaporation 35%, and percolation 43% of the 2,835 mm of rainfall over a 12-month period. Direct interception of cloud water was less than 305 mm/yr. The 984 mm of evaporation was 30% greater than that often extrapolated for the critically water short Pearl Harbor groundwater basin. (See also W88-01203) (Author's abstract)
W88-01217

2E. Streamflow and Runoff

HYDRODYNAMICS AND MODELING OF RE-REGULATION POOLS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 2H.
W88-01055

HISTORY OF THE CADDO RIVER WATERSHED,
Ouachita Baptist Univ., Arkadelphia, AR.
For primary bibliographic entry see Field 6G.
W88-01058

CHANNEL DEVELOPMENT IN THE LOWER REACH OF THE RED RIVER,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W88-01187

ADVANCES IN GAUGING OPEN CHANNELS AND RIVERS USING ULTRASONIC AND ELECTROMAGNETIC METHODS,
Sarasota Automation Ltd., Winchester (England). Environmental Systems Div.
For primary bibliographic entry see Field 7B.
W88-01206

COMPARATIVE ANALYSIS OF VARIOUS RAINFALL-RUNOFF MODELS,
Interamerican Center for Integral Development of Land and Water Resources, Merida (Venezuela).
For primary bibliographic entry see Field 2A.
W88-01220

STATISTICAL FLOW FORECASTING MODEL FOR SMALL CATCHMENTS,
Clemson Univ., SC. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W88-01221

TEST OF RAINFALL-RUNOFF MODELS AS ELEMENTS OF FLOOD FORECASTING MODELS FOR BIG RIVERS,
K. Ludwig.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 111-115, 3 fig, 1 tab, 7 ref.

Descriptors: *Rainfall-runoff relationships, *Model studies, *Flood forecasting, *Hydrometeorology, *Rhine River, Mathematical models, Hydrologic models, Koehler Model, Horton Model, Linear Storage Model, Clark Model, Simplified Clark Model, Parallel Storage Model.

Test investigations of different methods for flood forecasting in big rivers are being carried out in Germany. A relatively small stretch of the Rhine between Karlsruhe and Worms including the Neckar River basin is being used as test object for these investigations. As part of these investigations, different types of rainfall-runoff models are being tested. These will be connected by flood routing models later to produce system models as a basis of flood forecast in big rivers. Eight models were tested: (1) Constant Runoff Coefficients; (2) Constant Loss Rates; (3) Koehler Model; (4) Horton Model; (5) Linear Storage Model; (6) Clark Model; (7) Simplified Clark Model; and (8) Parallel Storage Model. A judgment of model efficiency was done by counting the good simulation results, which were expressed by hydrologic deviations below a defined threshold value. This way of model comparison was chosen to prevent any comparison which many have been affected by bad simulation results produced by data errors. Though several model combinations produce a similar number of good results, the best results were produced by the combinations of Koehler method - simplified Clark model and constant runoff coefficient - parallel storage model. As such, they will both be used in the further investigation of flood forecasts with the river basin model. (See also W88-01203) (Lantz-PTT)
W88-01222

RAINFALL RELATED PROBLEMS IN OPERATING THE GARD FLOOD WARNING SYSTEM,
Institut National Polytechnique de Grenoble (France).
C. Obled, and J.-D. Creutin.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 159-169, 8 fig, 8 ref. Contract No. 650-529.

Descriptors: *Rainfall-runoff relationships, *Warning systems, *Flood warning, *Rainfall-runoff relationships, *Hydrometeorology, *Rainfall, *Forecasting, *Flood forecasting, *France, Seasonal variation, Model studies, Precipitation, Statistical studies, Rainfall intensity.

The southeastern side of the Massif Central, in France, frequently undergoes very strong rainfall events occurring generally between August and November (total event rainfalls in the range 250-500 mm over 2 to 4 days, hourly rainfalls usually over 20 mm/hr and may reach 50 to 80 mm/hr). A pilot project has been set up in the central part of this region, with a real time data acquisition system and a flood forecasting model. The development of the latter came up against several problems caused by poor knowledge of the rainfall properties, both spatial and temporal, in this region. These problems are briefly reviewed and discussed. First, some statistical structural properties are given, both for the total rainfall events and for the hourly rainfall fields. Their impact on network density requirements and on uncertainties regarding the estimated average rainfalls in small watersheds is considered. In addition, the role of altitude is considered. However, this variable was eventually detected from operational use. Some results are also given on sophisticated evaluation of watershed averages, as compared with more common approaches like Thiessen or arithmetic means. Another problem is the lack of reliable short term rainfall forecasts (2 to 6 hours). The usefulness of currently available forecasts (24 hr) is considered, as well as the operational use of a synthetic rainfall generator (which takes into account the already observed hourly rainfall), as an aid to the forecaster. (See also W88-01203) (Author's abstract)
W88-01229

GATLINBURG, TENNESSEE, FLASH FLOOD WARNING AND EVACUATION SYSTEM,
Tennessee Valley Authority, Knoxville. Floodplain Management Branch.
C. W. Bell.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 171-178, 7 fig.

Descriptors: *Hydrometeorology, *Warning systems, *Flood warning, *Telemetry, *Automation, *Flash floods, *Tennessee, *Gatlinburg, *Flood forecasting, *West Prong Little Pigeon River, Flood plain management, Rainfall intensity, Gages, Hydrologic models, Evacuation plans.

Gatlinburg, Tennessee, is the major gateway to the Great Smoky Mountains National Park; which together with other area attractions results in a substantial population increase during the summer months. Many of these visitors patronize motels and other businesses located in the West Prong Little Pigeon River floodplain. The river is highly prone to flash flooding. The Gatlinburg flash flood warning system is an automated computer operated rainfall and stream level monitoring system with data analysis capability. It provides a timely warning of the potential for a flash flood. The system consists of a central station; a repeater station; six remote hydrological stations; and a local stream gage. Radio telecommunication is used to address the remote stations and transmit data to the central station. The local stream gage data is transmitted to the central computer over a dedicated phone line. The computer is programmed to take the hydrologic information and utilizing a continually self-adjusting hydrologic model of the watershed forecast flood states in Gatlinburg. The system is being operated by the city personnel and is designed to operate for long periods without attention. The system became operational in December 1981. The evacuation plan has been completed and will be implemented shortly. (See also W88-01203) (Author's abstract)
W88-01230

FLOOD FORECASTING/WARNING SYSTEM FOR IBADAN, NIGERIA,
Ibadan Univ. (Nigeria). Dept. of Civil Engineering.
T. A. Oyekan, and J. R. Rogers.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 179-185, 5 fig, 3 tab, 5 ref.

Descriptors: *Warning systems, *Flood warning, *Hydrometeorology, *Flood forecasting, *Ibadan, *Nigeria, *Rainfall-runoff relationships, *Rainfall, Rainfall intensity, Flooding, Flood plain management, Hydrologic models.

The city of Ibadan with population exceeding 2 million, is the second largest city in Africa. River Ogunpa and its tributaries transverse the city. Ibadan has been plagued by flooding from torrential rains for years. The last two floods of 1978 and 1980 claimed 40 and > 700 lives, respectively. Additionally, minor flooding frequently occurs during lesser storms. Immediately after the 1980 flood, Ibadan was without drinking water for > 3 wk due to the damage of Eleiyele dam - the city's major source of drinking water. Based on previous rainfall records, a typical Stage versus Rainfall Intensity curve was developed. An extensive network of stage recorders and rain gages will be installed. During heavy storms, adequate forecast and warning will be dispatched once a critical rainfall intensity is attained. A rainfall-runoff model will also be calibrated for more accurate stage predictions. Following the successful calibration of the model, the system will be made available to government officials, radio and television stations for their consideration and eventual implementation of the system. (See also W88-01203) (Author's abstract)
W88-01231

UTILIZATION OF HYDROMETEOROLOGICAL MONITORING SYSTEMS TO ENHANCE RESERVOIR OPERATIONS DURING FLOOD EMERGENCIES,
Salt River Project, Phoenix, AZ. Water Resources Operations.
D. S. Wilson, and D. H. Phillips.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 187-191.

Descriptors: *Hydrometeorology, *Flood control, *Reservoir operation, *Salt River, *Gila River, *Arizona, *Monitoring, Flooding, Reservoirs, Salt River Project, Flood routing, Flood plain management, Flood flow.

The Salt River Project (SRP) is a utility which supplies water and electricity to metropolitan Phoenix, Arizona. Phoenix is located in South Central Arizona on the Salt River near its confluence with the Gila River. Serious interruption to normal transportation patterns, damages to private and public property and loss of lives are generally associated with flood flows in the Salt River. SRP operates a system of six water storage reservoirs which regulate the normal flows of the Salt River and its major tributaries, the Verde River and Tonto Creek; these reservoirs were constructed during the period 1910-1946 as conservation facilities. Based on updated hydrometeorology, it is known that the dams have inadequate capacities and outlet works to control flood flows such as those experienced in 1978, 1979, and 1980. SRP must rely on a comprehensive emergency reservoir operation procedure to ensure dam safety requirements and minimize the effects of flood flows on the downstream communities until facility improvements can be realized. The extensive efforts by the Salt River Project and cooperating agencies to monitor weather, watershed, stream flow and reservoir conditions enhance reservoir operation decision making. Those efforts, the cooperative nature of their maintenance and operation, and the improvements in decision making that can be realized from effective monitoring and forecasting of weather and runoff are described. (See also W88-01203) (Author's abstract)
W88-01232

HYDROMETEOROLOGY OF A MAJOR FLOOD IN SOUTH AFRICA,
Stellenbosch Univ. (South Africa). Dept. of Geography.
For primary bibliographic entry see Field 2B.
W88-01233

IMPORTANCE OF STREAMFLOW FORECASTING TO WATER MANAGEMENT WITH INSTREAM FLOW CONSIDERATIONS,
Fish and Wildlife Service, Fort Collins, CO.
R. T. Milhous.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 207-211, 4 fig, 9 ref.

Descriptors: *Hydrometeorology, *Streamflow forecasting, *Fisheries, Model studies, *Forecasting, *Water management, *Instream flow, Water supply.

By being able to model physical habitat and the water resources system, and to forecast the water supply, a water manager, and fisheries themselves, can negotiate a water resources plan for the future which will maximize the benefits derived from the water supply available. A use which can be significantly improved by forecasting is the instream uses of water. In many existing water management schemes, it is the instream flows that are sacrificed to cover the uncertainties in streamflow forecasting and to assure a continuous supply of water for out-of-stream uses. Unfortunately, much of the value received from the instream flows is destroyed by short periods of very low flows. The use of streamflow forecasts to reduce the possibility of very low flows and the allocation of available water prior to a drought is considered. (See also W88-01203) (Lantz-PTT)
W88-01235

DURATION OF STREAM TEMPERATURE INCREASES FOLLOWING FOREST CUTTING IN THE SOUTHERN APPALACHIAN MOUNTAINS,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
For primary bibliographic entry see Field 4C.
W88-01245

APPLICATION OF IFG'S INSTREAM WATER TEMPERATURE MODEL IN THE UPPER COLORADO RIVER,
Soil Conservation Service, Fort Collins, CO.
F. D. Theurer, K. A. Voos, and C. G. Prewitt.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 287-292, 3 fig, 11 ref.

Descriptors: *Model studies, *Environmental impact, *Hydrometeorology, *Water temperature, *Colorado River, *Data acquisition, Instream flow, Streamflow, Measuring instruments, Model studies.

An instream water temperature model has been developed, verified, validated, and applied by the Instream Flow and Aquatic Systems Group (IFG). Using readily available hydrometeorological data, the model predicts average daily water temperature and diurnal fluctuations within a stream network. Various solution techniques are available ranging from desktop calculator programs designed for simple applications to a sophisticated computer program designed for complex systems, large data volumes, or repetitive applications. The application of the model and possible interpretations of its results are discussed with respect to two endangered fish species in the Upper Colorado River Basin. Complete documentation for the model and solution techniques is available from IFG. (See also W88-01203) (Author's abstract)
W88-01248

DEVELOPMENT OF A SURFACE WATER SUPPLY INDEX - A DROUGHT SEVERITY INDICATOR FOR COLORADO,
Colorado Div. of Water Resources, Denver.
L. E. Dezman, B. A. Shafer, H. D. Simpson, and J. A. Danielson.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 337-341, 3 fig, 3 ref.

Descriptors: *Hydrometeorology, *Water yield, Forecasting, *Water demand, *Water shortage, *Surface water, *Water supply, *Drought severity, *Colorado, Surface Water Supply Index, Water resources management, Probability distribution, Precipitation, Streamflow, Hydrologic properties.

Colorado's droughts of 1976-77 and 1980-81 were the impetus for the development of a Surface Water Supply Index. SWSI and the Palmer Index are currently the two indices recognized in the Colorado Drought Response Plan as triggering mechanisms to officially monitor drought conditions and activate appropriate impact task forces to deal with its effects. SWSI is mean to serve those areas dependent on surface water supplies originating as snowmelt in the mountains and classified as mountain water dependent. A single SWSI number is generated monthly and displayed in map form for each major basin in Colorado. The index number is derived from the probability distributions of snow course, precipitation, reservoir, and streamflow data to accurately reflect the state's hydrologic variability. Each of the constituent variables in the index is weighted in proportion to its probable impact on total surface water resources in the basin. The SWSI's produced are thus numerical values that express the current and future availability of water supplies to meet a multitude of competitive demands. The range of SWSI values is from -4.0 (prospective supplies extremely poor) to +4.0 (prospective water supplies abundant). The SWSI number is a general indicator of basin-wide surface water supply conditions. (See also W88-01203) (Lantz-PTT)
W88-01257

USE OF HYDROMETEOROLOGICAL DATA IN DROUGHT MANAGEMENT: POTOMAC RIVER BASIN CASE STUDY,
Interstate Commisson the Potomac River Basin, Rockville, MD. Cooperative Water Supply Operations on the Potomac River.
J. A. Smith, D. P. Sheer, and J. C. Schaake.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 347-354, 4 fig, 3 tab, 11 ref.

Descriptors: *Hydrometeorology, *Water yield, *Streamflow forecasting, *Geohydrology, *Drought, *Water management, *Potomac River, Data collections, Low flow, Streamflow, Model studies, Sacramento Soil Moisture Accounting Model, Forecasting, Water supply, River basins.

The low streamflow regimen in the Potomac River basin is strongly associated with geologic features of the basin. The sharp hydrologic contrasts between regions draining shale, metasedimentary rocks, and carbonate rocks are not peculiar to the Potomac River basin, but are generally valid for the Central and Southern Appalachians. The Sacramento Soil Moisture Accounting Model is the central component for the Potomac River basin. The Sacramento model is especially appealing in that its parameters have physical interpretations which are consistent with the results discussed in a section on 'Hydrogeology of Low Streamflow in the Potomac River Basin.' As an extension of this observation, it is suggested that hydrologic province maps may be useful in obtaining good initial estimates of Sacramento model parameters for uncalibrated areas from the calibrated Potomac River basin parameters. The final topic concerns application of the streamflow forecasting system to water supply management. The CO-OP model simulates, on a daily time step, the principal water supply and demand features of the Washington Metropolitan Area. The CO-OP model is linked with the ESP procedure to produce a forecasting tool for water supply management during drought periods. In particular the system produces probabilities of water shortage and refilling reservoirs. (See also W88-01203) (Lantz-PTT)
W88-01259

SPATIAL CHARACTERISTICS OF SEVERE DROUGHT IN THE SACRAMENTO RIVER BASIN,
California Univ., Davis. Dept. of Geography.
M. L. Shelton.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 355-360, 3 fig, 5 ref.

Descriptors: *Hydrometeorology, *Streamflow forecasting, *Reservoir operation, *Drought, *Sacramento River, *California, River basins, Spatial distribution, Water budget, Reservoirs, Water supply, Water shortage.

Precipitation in California during water year 1977 was the lowest in 138 years of record. Hydrologic effects of the drought were especially significant in the Sacramento River basin because this watershed contains about one-third of the reservoirs in California and about one-half of the total intrastate reservoir storage capacity. A severe drought in 1924 stimulated construction of many of the water storage and transmission facilities that exist in the basin today. The severity of the and 1924 and 1977 droughts is compared by analysis of cumulative water deficiencies derived from parameters representing natural moisture flux processes and calculated using Thornthwaite's climatic water budget. Isopleth maps of cumulative moisture deficiencies for 1924 and 1977 facilitate inclusion of a spatial factor in quantifying drought severity. Area weighting of cumulative moisture deficiencies reveals that runoff during the longer duration 1977 drought was 14.6 cu km less than during 1924 and moisture availability during typically dry months was 5 cu less during the 1977 drought. (See also W88-01203) (Author's abstract)
W88-01260

DETERMINING DROUGHT EFFECTS ON SURFACE WATER BODIES NEAR A NEW WELLFIELD,
West Coast Regional Water Supply Authority, Clearwater, FL.
C. Palmer.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 361-366, 4 fig, 5 ref.

Descriptors: *Hydrometeorology, *Drought, *Wellfields, *Surface-groundwater relations, *Florida, Water shortage, Surface water, Surface water availability, Hydrologic studies, Aerial photography.

The start-up of the Cross Bar Ranch Wellfield in central Pasco County, Florida, was coincident with a major state-wide drought. During this drought many shallow surface water bodies experienced low water levels or dry conditions. If these low water levels were significantly due to wellfield operations, mitigating actions were to be taken by the West Coast Regional Water Supply Authority under the Special Conditions of the permit to operate the wellfield. An intensive hydrologic analysis of these surface water bodies was undertaken. Central to this analysis were historical data from aerial photographs. This, combined with classical hydrologic analysis, demonstrated that the observed low water levels were drought related and not caused by the Water Year 1981 Cross Bar Ranch pumpage of 12.9 MGD. (See also W88-01203) (Author's abstract)
W88-01261

SITE SPECIFIC PROBABLE MAXIMUM PRECIPITATION ESTIMATES, UPPER SOUTH PLATTE RIVER BASIN, COLORADO,
J. T. Riedel, B. H. Wang, and J. L. Diebel.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 517-522, 6 fig, 3 tab, 5 ref.

Descriptors: *Hydrometeorology, *Forecasting, *Precipitation forecasting, *Flood forecasting, *Rainfall-runoff relationships, *South Platte River, *Colorado, *Probable maximum precipitation, Floods, Rainfall intensity.

Probable maximum floods (PMF) at Antero, Eleven-mile and Cheesman Dams on the headwaters of the South Platte River in Colorado were estimated through a site specific hydrometeorological and hydrologic study. This study included estimation of probable maximum precipitation (PMP) by storm transposition and maximization and a determination of the rainfall-runoff relationship by the dimensionless graph-lag curve method. Drainage sites of interest are between approximately 200 and 2000 mi. Major rainfalls in the South Platte River basin and vicinity show patterns that are closely associated with the terrain features. The storm rainfall history in the region is one of modest rainfall in the mountainous areas and very severe rainfalls in the areas where the plains meet the foothills. Due to the great difference in climate within a short distance, major efforts were needed to determine which storms should be transposed and how these storms should be adjusted in estimating PMP. The procedure and results of PMP analysis are presented. (See also W88-01203) (Author's abstract)
W88-01284

REGIONAL HYDROMETEOROLOGICAL ANALYSIS FOR SPILLWAY DESIGN,
Washington State Dept. of Ecology, Olympia.
For primary bibliographic entry see Field 8B.
W88-01285

100-YEAR 24-HOUR EVENT: FACT OR FICTION,
HydroDynamics, Inc., Parker, CO.
J. S. Fifield.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 531-534, 8 fig, 3 ref.

Descriptors: *Hydrometeorology, *Flood forecasting, *Flood frequency, *Flow profiles, *Peak flow, Hydraulic properties, Floods, Flood hydrographs, Precipitation, Rainfall distribution, Rainfall intensity, Simulation analysis.

For the hydrologic engineer, it is important that peak flows resulting from a 24-hour climatic event be representative of the area under investigation. An important parameter for determining peak flow (and in generating the accompanying hydrograph) from an ungaged watershed is utilizing an accurate time distribution for the design storm. Frederick , et al. (1981), developed a method for determining how precipitation is distributed with respect to time for various areas throughout the western United States. By comparing 100-year 24-hour flood hydrographs simulating flows from ungaged watersheds using the Frederick, et al., distribution to the Soil Conservation Service Type I or Type II distribution, it becomes evident that serious hydrologic errors could develop for which the hydrologic engineer would be responsible. (See also W88-01203) (Author's abstract)
W88-01286

FREQUENCY ESTIMATES OF WATER AVAILABLE FOR RUNOFF DUE TO PRECIPITATION AND/OR SNOWMELT,
National Weather Service, Silver Spring, MD. Office of Hydrology.
F. Richards, J. Miller, E. Zurndorfer, and N. Foat.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 535-540, 4 fig, 8 ref.

Descriptors: *Hydrometeorology, *Runoff forecasting, *Model studies, *Rainfall-runoff relationship, *Runoff, *Precipitation, *Rainfall intensity, *Snowmelt, *Data interpretation, Model studies, Spatial distribution, Snowpack.

Climatic precipitation and temperature data were used as input to a snow accumulation and ablation model that yielded annual maximum WAR (water available for runoff) series. These data were fit a Fisher-Tippett Type I frequency distribution and the resulting values were used to produce maps of WAR-frequency estimates. The broad features of the spatial variation of the WAR field were qualitatively similar to previously published precipitation-frequency maps at the shorter durations, with the WAR values generally about 10% larger for the 24-hr duration. As the duration increased, the WAR values became progressively larger than corresponding precipitation values. The increase was greatest in higher elevations where snowpack accumulation and spring snowmelt were considerable. At durations in excess of five days, there were broad higher elevation regions where the WAR-frequency values were more than 50% greater than corresponding precipitation-frequency values. (See also W88-01203) (Lantz-PTT)
W88-01287

FLOOD FREQUENCY ANALYSIS WITH DETECTION AND MODIFICATION OF OUTLIERS,
Illinois State Water Survey Div., Champaign.
K. P. Singh, and M. Nakashima.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 541-545, 3 fig, 1 tab, 9 ref.

Descriptors: *Hydrometeorology, *Flood forecasting, *Outliers, *Flood frequency, *Frequency analysis, Statistical methods, Statistical studies, Monte Carlo method, Flood design.

An outlier in a set of data is an observation which appears to be inconsistent with the remainder of that set of data. In flood frequency analysis, such an outlier significantly affects or distorts the distribution and hence the design flood estimates. Therefore, it is desirable to detect and modify outliers before conducting flood frequency analysis. Test statistics have been developed by extensive Monte Carlo experiments for detecting and modifying outliers in an observed flood series. Methods of transforming flood series into quasi-normal series were investigated, and power transformation was found to be the most suitable. A new flood frequency methodology has been developed to: (1) transform a flood series into a quasi-normal series; (2) perform statistical tests on the series to detect outliers at various probability levels; (3) modify outliers, if any, and transform the modified series back to a flood series; and (4) estimate design floods for various recurrence intervals using normal, log-Pearson type III, and mixed (mixture of two normals) distributions. Flood frequency analysis with mixed distribution, coupled with objective detection and modification of outliers, provided very satisfactory results for about 200 flood series analyzed. (See also W88-01203) (Author's abstract)
W88-01288

DAM BREACH PARAMETERS, OUTFLOW PEAKS, AND FLOOD STAGES,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 8B.
W88-01290

FLOOD HYDROLOGY OF STREAMS IN NORTHERN UTAH,
Gingery Associates, Inc., Englewood, CO.
P. Dass, R. L. Lambert, and D. D. Clement.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 559-564, 3 fig, 11 ref.

Descriptors: *Hydrometeorology, **Flood frequency, *Statistical analysis, *Floods, *Utah, *Model studies, Hydrologic properties, Streams, Regression analysis, Rainfall, Simulation analysis, Flow profiles.

The hydrologic investigations reported in this publication relate to streams through 20 communities in Northern Utah. In general, these streams develop in the Wasatch mountains and flow through the mountainous canyons to the populated valley areas downstream, eventually terminating into the Great Salt Lake. The study area watersheds are subjected to high-intensity short-duration cloudburst type thunderstorms. The stream gage records available in the area are separated into the snowmelt and rainfall induced flood peaks which are analyzed for Log Pearson Type III distribution for both rainfall and snowmelt events. Due to lack of sufficient gage data related to rainfall caused flood events, 16 of the watersheds are modeled to simulated 10-, 50-, and 100-year recurrence interval rainfall caused flood events. The model used for simulation is the Storm Water Management Model developed by the Environmental Protection Agency. The model is calibrated by using information available on several historical floods in the area. Regression equations are developed to predict 10-, 50- and 100-year recurrence interval flood flows for both snowmelt and rainfall caused flood events. The discharge-frequency distributions for these events are statistically combined to give discharge-frequency distributions for the combined events. The regression equations presented here may be used for streams along the Wasatch Front Range in Northern Utah and for other hydrologically similar areas. (See also W88-01203) (Author's abstract)
W88-01291

MULTIDISCIPLINARY APPROACH TO THE FLOOD HYDROLOGY OF FOOTHILL STREAMS IN COLORADO,
Geological Survey, Denver, CO. Water Resources Div.
R. D. Jarrett, and J. E. Costa.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 565-569, 4 fig, 11 ref.

Descriptors: *Hydrometeorology, *Rainfall-runoff relationships, *Flood frequency, *Floods, *Streams, *Colorado, *Peak flow, Hydrologic properties, Rainfall, Snowmelt, Rainfall-runoff relationship, Flooding, Flood profiles, Detritus.

Conventional hydrologic analyses fail to adequately describe the flood hydrology of foothill streams in Colorado. Annual peak flows are derived from snowmelt, rainfall, or a combination of rain on snow. When snowmelt- and rain-generated peaks are examined separately, flood-frequency analyses show different trends based upon elevation. Above about 7,500 ft (2,300 m), snowmelt dominates; rain generally does not contribute to the flood potential for recurrence intervals less than the 100-year flood. Where rainfall does significantly contribute to flooding above about 7,500 ft (2,300 m), unit discharges are small when compared with lower elevation floods resulting from rainfall. Below about 7,500 ft (2,300 m), rainfall-produced floods predominate. Stratigraphic and geomorphic evidence supports these conclusions and indicates that catastrophic cloudbursts floods in foothill zones have recurrence intervals on the order of thousands of years at any given site. In small basins above 7,500 ft (2,300 m), many large floods attributed to intense rainfall are, in fact, debris flows and not waterfloods. A paleohydraulic method using maximum boulder sizes was developed to reconstruct historic maximum flood peaks in small ungaged foothill basins. (See also W88-01203) (Author's abstract)
W88-01292

DRAINAGE CLIMATOLOGY FOR CALIFORNIA,
California State Dept. of Water Resources, Sacramento.
For primary bibliographic entry see Field 2B.
W88-01294

WATER QUALITY MODELING OF REGULATED STREAMS,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5G.
W88-01324

OPTIMUM LOCATION OF A WELL NEAR A STREAM,
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 4B.
W88-01345

IMPORTANCE OF PROTECTION THE OPEN CASTS FROM UNDERGROUND AND SURFACE WATER CONCERNING SLOPE STABILITY ASPECTS,
For primary bibliographic entry see Field 2F.
W88-01426

2F. Groundwater

GROUND WATER CONTAMINATION BY ALDICARB PESTICIDE IN EASTERN SUFFOLK COUNTY, LONG ISLAND,
Geological Survey, Syosset, NY. Water Resources Div.
For primary bibliographic entry see Field 5B.
W88-01102

NONPOINT SOURCE CONTAMINATION OF GROUND WATER IN KARST-CARBONATE AQUIFERS IN IOWA,
Iowa State Geological Survey, Iowa City.
For primary bibliographic entry see Field 5B.
W88-01103

NONPOINT SOURCE IMPACTS ON GROUND WATER QUALITY IN MAJOR LAND RESOURCE AREAS OF THE SOUTHWEST,
Agricultural Research Service, Durant, OK.
For primary bibliographic entry see Field 5G.
W88-01105

AGRICULTURAL SOURCES OF NITRATE CONTAMINATION IN A SHALLOW SAND AND GRAVEL AQUIFER OF EASTERN SOUTH DAKOTA,
South Dakota Dept. of Water and Natural Resources, Pierre.
For primary bibliographic entry see Field 5B.
W88-01132

GROUND WATER QUALITY STANDARDS,
Nebraska State Dept. of Environmental Control, Lincoln.
For primary bibliographic entry see Field 5G.
W88-01174

LINEAR-FLOW INTERPRETATION OF THE H-3 MULTIWELL PUMPING TEST CONDUCTED AT THE WASTE ISOLATION PILOT PLANT (WIPP) SITE,
Sandia National Labs., Albuquerque, NM. Earth Sciences Div.
D. Tomasko, and A. L. Jensen.
Available from the National Technical Information Service, Springfield, VA. 22161. Price codes A03 in paper copy, A01 in microfiche. Sandia Report No. SAND87-0630, July 1987. 38 p, 27 fig, 3 tab, 24 ref. DOE Contract No. DE-AC04-76DP00789.

Descriptors: *Underground waste disposal, *Groundwater movement, *Pumping tests, *Linear flow, *Data interpretation, *Waste isolation plants, *Wastewater treatment, Mathematical studies, Model studies, Hydraulic models, Flow profiles, Transmissivity, Mathematical models, Flow models.

An interpretation is presented of the H-3 multiwell pumping test conducted at the Waste Isolation Pilot Plan (WIPP) site in southeastern New Mexico between October 15, 1985, and April 12, 1986. Unlike previous interpretations of this test that used a double-porosity radial-flow model, this interpretation is based on a linear-flow process. Two techniques were developed to analyze the H-3 data with a linear-flow conceptualization. The first technique was used to find the orientation of the linear feature using data from a multiwell interference test by minimizing the squared differences between field observations and linear flow calculations. The second technique was used to calculate the transmissivity and width of the feature. To calculate consistent system parameters, this technique required developing a least-squares fitting procedure to minimize the effects of noise in the drawdown measurements. Linear flow analyses of the H-3 data yield the following parameter values for the linear feature: an average width of approximately 7000 ft; an orientation of N 29 W; average transmissivities of approximately 2,9, and 19 sq ft/D at the pumped well, and between the pumped well and DOE-1 and H-11, respectively; and an effective radius of the pumped well equal to approximately 250 ft. These findings are consistent with detailed two-dimensional numerical simulations with the SWIFT II computer code, recent geophysical interpretations of Controlled Source Audio Magneto Telluric surveys of the southern portion of the site, and double-porosity, radial-flow interpretations. (Lantz-PTT)
W88-01189

DETERMINING DROUGHT EFFECTS ON SURFACE WATER BODIES NEAR A NEW WELLFIELD,
West Coast Regional Water Supply Authority, Clearwater, FL.
For primary bibliographic entry see Field 2E.
W88-01261

GROUNDWATER HYDRAULICS.
Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. 407 p. Edited by Joseph S. Rosenshein and Gordon D. Bennett.

Descriptors: *Groundwater hydraulics, *Groundwater, *Groundwater movement, *Model studies, *Aquifers, *Pumping tests, Groundwater management, Hydraulics, Data interpretation, Groundwater pollution, Wells, Solute transport, Pumping, Confined aquifers, Leaky aquifers, Drawdown, Planning.

A wide range of hydraulic problems are addressed in papers reflecting the current state-of-the-art of groundwater hydraulics. Theoretical solutions are provided for field problems concerned with optimum location of a well near a stream, prediction of transient movement of solid particles in response to pumping confined aquifer systems, average regional land subsidence equations for artesian aquifers, approximations of drawdown patterns of multiple well systems in layered soils, and unsteady drawdown in the presence of linear discontinuity. New type curve solutions obtained by numerical inversion of Laplace transform solutions are presented for analysis of pumping test data. The current status of the hydrologist's ability to apply hydraulics to solve groundwater problems in fractured aquifer formations is reviewed and demonstrated by analysis of test data from several pumping tests. Methods of obtaining aquifer parameters from analysis of tracer-injection and slug field tests were presented. Subjects related to modeling and reflecting the advanced capability of the groundwater scientist to apply theoretical aspects in the modeling of complex groundwater problems were presented in several papers. (See W88-01345 thru W88-01361) (Wood-PTT)
W88-01344

OPTIMUM LOCATION OF A WELL NEAR A STREAM,
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 4B.
W88-01345

ANALYSIS OF SEDIMENTARY SKELETAL DEFORMATION IN A CONFINED AQUIFER AND THE RESULTING DRAWDOWN,
Lawrence Livermore National Lab., CA.
D. C. Helm.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 29-82, 12 fig, 32 ref.

Descriptors: *Subsidence, *Compaction, *Leaky aquifers, *Hydraulics, *Confined aquifers, *Drawdown, *Aquifers, Particle movement, Prediction, Mathematical equations, Mathematical studies, Pumping.

A method for predicting transient three-dimensional movement of solid particles at depth in response to pumping a confined aquifer was developed. Calculating particle movement allowed the mathematical determination of the transient change in fluid pressure within deforming pore spaces whose change in volume was calculated as an intermediate step. In order to accomplish this, equations for three-dimensional movement of solids were derived with emphasis on what underlying assumptions were required. Using these equations, horizontal and vertical components of displacement were calculated based on specified boundary and initial conditions which were analogous to those used in the standard theory of leaky aquifers. Analytic solutions for the axially symmetric displacement and the resulting strain and change in fluid pressure were plotted nondimensionally as type curves which were compared to the commonly used theory of leaky aquifers. (See also W88-01344) (Wood-PTT)
W88-01346

AVERAGED REGIONAL LAND SUBSIDENCE EQUATIONS FOR ARTESIAN AQUIFERS,
Technion - Israel Inst. of Tech., Haifa.
For primary bibliographic entry see Field 6G.
W88-01347

MULTIPLE-WELL SYSTEMS IN LAYERED SOILS,
Technion - Israel Inst. of Tech., Haifa.
S. Irmay.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 108-124, 8 fig, 3 tab, 13 ref.

Descriptors: *Well hydraulics, *Wells, *Layered soils, *Groundwater, *Drawdown, *Mathematical equations, Mathematical studies, Aquifers, Permeability coefficient, Hydraulics, Hydraulic systems, Drainage.

Multiple-well systems or batteries of wells occur in water supply, oil fields, and drainage by well points. Mathematical equations are presented as approximations for the drawdowns of such systems under a variety of conditions. The effects of the number of wells, well spacing distance, water depth, aquifer transmissivity, shape of the multiple-well system, soil types, flow characteristics, and other variables are shown mathematically. Previous approximations are discussed. (See also W88-01344) (Wood-PTT)
W88-01348

UNSTEADY DRAWDOWN IN THE PRESENCE OF A LINEAR DISCONTINUITY,
Nevada Univ. System, Las Vegas. Desert Research Inst.
P. R. Fenske.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 125-145, 9 fig, 1 tab, 11 ref. DOE Contract No. DE-AC08-81NV10162.

Descriptors: *Unsteady drawdown, *Drawdown, *Well hydraulics, *Groundwater movement, *Pumping tests, Mathematical equations, Mathematical studies, Superposition, Diffusivity, Aquifers, Mississippi.

The mathematical equations for unsteady drawdown in the presence of linear discontinuity were developed by superposition (image theory). The resultant equations are relatively simple and include analysis of diffusivity contrasts. The approach to the problem is unconventional and the proposed equations are not shown to be exact solutions to the appropriate partial differential equation. However, if not exact, the proposed equations are good approximations and provide insight into a well hydraulics problem. Implicit consideration was given to the discontinuities caused by facies change in the aquifer skeleton, though discontinuities may also be caused by changes in fluid density, viscosity, or compressibility. The first two of these other parameters affect the fluid conductivity of the aquifer and the third affects the storativity. Two pumping tests on the top of Tatum Salt Dome in Mississippi, appear to show linear discontinuities using the presented concepts. (See also W88-01344) (Wood-PTT)
W88-01349

ANALYSIS OF CONSTANT DISCHARGE WELLS BY NUMERICAL INVERSION OF LAPLACE TRANSFORM SOLUTIONS,
Geological Survey, Menlo Park, CA.
A. Moench, and A. Ogata.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 146-170, 6 fig, 1 tab, 28 ref.

Descriptors: *Well hydraulics, *Pumping tests, *Groundwater movement, *Laplace equation, Mathematical equations, Boundary processes, Diffusion equation, Mathematical studies, Numerical inversion, Hydraulics.

Analytical solutions to many boundary value problems for wells discharging at a constant rate have not been applied frequently by groundwater hydrologists because they are difficult to evaluate numerically. However, solutions can be evaluated accurately using a simple numerical Laplace transform inverter. The advantages of working in the Laplace plane were demonstrated by combining solutions of the subsidiary differential equation for various boundary value problems to form new solutions for well test problems. Type curves for such extended problems were generated without difficulty with the numerical Laplace transform inverter. Such solutions obtained analytically might otherwise be mathematically intractable. The numerical inversion algorithm described by Stehfest in 1970 was used on the Laplace transform in the application to several problems pertinent to the analysis of well test data for wells that discharge at a constant rate. (See also W88-01344) (Wood-PTT)

W88-01350

PUMPING TEST ANALYSIS IN FRACTURED AQUIFER FORMATIONS: STATE OF THE ART AND SOME PERSPECTIVES,
Research Council of Alberta, Edmonton.
C. Sauveplane.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 171-206, 10 fig, 7 tab, 15 ref.

Descriptors: *Aquifers, *Pumping tests, *Data interpretation, *Model studies, *Groundwater movement, *Fractured aquifers, Groundwater, Confined aquifers, Pump wells, Mathematical studies, Mathematical equations, Mathematical models.

An overview of available models that can be used to analyze constant-rate test data for fractured and confined aquifers is presented. Basic assumptions and equations are given, together with analytical and graphical solutions. Groundwater flow toward the pumped well takes into account idealized representations of the fracture network based on double-porosity medium theory or on an equivalent single fracture configuration. In both types of specific models, the Theis type curve derived for homogeneous and porous media is obtained as a long time or a large geometric parameter asymptotic solution. As a consequence, the Theis model is usually inapplicable to the interpretation of tests of economical duration, and the matching process is not usually accurate. An approximate solution to the Boulton-Streltsova layered model was derived and tested on field data; its accuracy, compared to the exact solution, is judged sufficient for interpretive purposes. Solutions to several other models were also compared. It is emphasized that the selection of the most appropriate specific model must be primarily based on the hydrogeological and geological information available. (See also W88-01344) (Wood-PTT)
W88-01351

FIELD TEST FOR EFFECTIVE POROSITY AND DISPERSIVITY IN FRACTURED DOLOMITE, THE WIPP, SOUTHEASTERN NEW MEXICO,
Sandia National Labs., Albuquerque, NM.
For primary bibliographic entry see Field 5B.
W88-01352

DIRECT CALCULATION OF AQUIFER PARAMETERS IN SLUG TEST ANALYSIS,
Princeton Univ., NJ. Water Resources Program.
V. Nguyen, and G. F. Pinder.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 222-239, 3 fig, 2 tab, 2 append. NSF Grant No. CME-702-006 and DOE Contract No. DE-AC03-80SF11489.

Descriptors: *Groundwater movement, *Pumping tests, *Aquifer characteristics, *Groundwater level, *Slug test analysis, *Data interpretation, *Mathematical studies, Aquifers, Test wells, Permeability coefficient, Mathematical equations.

A conceptually and computationally simple methodology was developed for determining aquifer parameters from water level observations in a single well. Problems which involved partially penetrating wells screened in aquifers where, at least in the short term, the effects of a water table or leakage from a confining bed could be disregarded were considered. The analytical apparatus was most appropriate for dealing with slug test analyses or short-term pumping tests in materials of moderate to low hydraulic conductivity. Appropriate assumptions and mathematical equations with their derivations are presented. (See also W88-01344) (Wood-PTT)
W88-01353

PRESSURE TRANSIENT ANALYSIS FOR HOT WATER GEOTHERMAL WELLS,
Systems, Science and Software, La Jolla, CA.
S. K. Garg, and J. W. Pritchett.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 242-255, 6 fig, 2 tab, 7 ref. DOE Contract No. DE-FC03-78ET27163.

Descriptors: *Groundwater movement, *Water yield, *Thermal water, *Geothermal wells, *Wells, *Pressure transient analysis, *Data interpretation, *Hydrothermal studies, Mathematical equations, Mathematical studies, Drawdown, Line source solution.

The applicability of the classical line source solution to analyze pressure transient data from hot water geothermal wells was investigated. The production data (pressure drawdown/buildup) from hot water wells may be analyzed in the usual manner to yield formation properties provided isenthalpic fluid compressibility is employed in the definition for total formation compressibility. Numerical results were provided to demonstrate that cold water injection data can be interpreted on the basis of the line source solution; it is, however, necessary in this case to use different values of kinematic viscosity (i.e., cold water kinematic viscosity for injection data and hot water kinematic viscosity for falloff data) for pressure buildup (i.e., injection) and for pressure falloff data. Discussions of previous work and appropriate mathematical equations are presented. (See also W88-01344) (Wood-PTT)
W88-01354

AQUIFER TESTING FOR THERMAL ENERGY STORAGE,
Kansas Univ., Lawrence.
A. D. Parr, F. J. Molz, and J. G. Melville.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 256-295, 16 fig, 4 tab, 35 ref. DOE Contract Nos. B-67770-A-0 and 7338.

Descriptors: *Thermal water, *Thermal energy storage, *Aquifer testing, *Confined aquifers, *Aquifers, *Groundwater movement, *Pumping tests, Alabama, Test wells, Hydraulic properties, Chemical properties, Permeability, Dispersivity, Heat capacity, Thermal conductivity, Field tests, Drawdown.

The hydraulic, thermodynamic, and chemical tests that were performed at the Mobile, Alabama site in order to obtain the data necessary for determining the potential of a confined aquifer for thermal energy storage were described. Important parameters include the regional gradient, vertical and horizontal permeability of the storage aquifer, horizontal dispersivity, vertical permeability of the upper and lower aquitards, thermal conductivities, heat capacities, and chemical characteristics of the aquifer matrix and native groundwater. At the Mobile site, chemical and thermodynamic tests were performed in the laboratory using core samples and groundwater samples. Chemical analyses indicated that there was a potential for clay particle swelling and loss of permeability in the storage aquifer if relatively pure water was heated and injected; the problem was eliminated by obtaining supply water from the storage aquifer itself. Methods for estimating thermodynamic properties are described. A series of new and existing wells were used for the pumping tests at the Mobile site during the extensive field tests required to determine the hydraulic properties. The series of pumping tests emphasized the importance of obtaining early drawdown data for each of the well tests because leakage or boundary effects can cause drawdown data for confined aquifers to deviate from the Theis curve very soon after pumping begins. (See also W88-01344) (Wood-PTT)
W88-01355

ANALYTICAL GROUNDWATER MODELING WITH PROGRAMMABLE CALCULATORS AND HAND-HELD COMPUTERS,
Geraghty and Miller, Inc., Savoy, IL.
For primary bibliographic entry see Field 7C.
W88-01356

NUMERICAL TREATMENT OF LEAKY AQUIFERS IN THE SHORT-TIME RANGE,
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Investigacion en Matematicas Aplicadas y en Sistemas.
For primary bibliographic entry see Field 7C.
W88-01357

GROUNDWATER MODELING OF DETAILED SYSTEMS,
Hydro-data, Inc., Tempe, AZ.
For primary bibliographic entry see Field 7C.
W88-01358

FORMULATION OF MODELS BASED ON THE AVERAGE CHARACTERISTICS OF A HETEROGENEOUS AQUIFER,
Florida Univ., Gainesville.
For primary bibliographic entry see Field 5B.
W88-01359

GALERKIN-FINITE ELEMENT TWO-DIMENSIONAL TRANSPORT MODEL OF GROUNDWATER RESTORATION FOR THE IN SITU SOLUTION MINING OF URANIUM,
Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 5B.
W88-01360

MAN-MADE POLLUTION OF GROUND WATER AND ITS GEOLOGICAL RELATIONS,
For primary bibliographic entry see Field 4B.
W88-01401

MINE WATER.
International Mine Water Association.
For primary bibliographic entry see Field 4B.
W88-01408

ACID MINE DRAINAGE PROBLEMS IN ENUGU COAL MINES OF ANAMBRA STATE, NIGERIA,
Anambra State Univ. of Technology, Awka (Nigeria). Dept. of Earth Sciences.
For primary bibliographic entry see Field 5B.
W88-01409

PROPOSALS ON MINE WATER CONTROL SYSTEM FOR KOTREDEZ COAL MINE,
Central Inst. for Mining Development, Budapest (Hungary).
For primary bibliographic entry see Field 4B.
W88-01410

ELEMENTAL HYDROGEOLOGICAL CHARACTERISTICS OF COALFIELDS IN CHINA AND THE PROBLEMS OF PROTECTING AGAINST MINE WATER,
Institute of Geology and Exploration, Xian (China).
M. Wang.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 41-51, 8 fig, 2 tab, 8 ref.

Descriptors: *Coal mining, *Mine drainage, *Groundwater, *Geohydrology, *Geologic formations, *China, Geologic fractures, Case studies, Karst hydrology, Groundwater movement, Karst.

According to the geotectonic background, regularities of coal accumulation, hydrogeological conditions, and considering the protecting methods against mine water, China's coalfields can be classified into six hydrogeological type regions: (1) Porous - fissure type region of Jurassic in Northeast China; (2) Porous - Karst type region of Carb-Permian in North China; (3) Fissure type region of Jurassic in Northwest China; (4) Fissure type region of Mesozoic in Yunnan - Tibet; (5) Karst type region of late Permian in South China; and (6) Fissure - Poro-type region of Tertiary in Taiwan. Emphasis was placed on the coalfields of Permo-Carboniferous in North China and late Permian in

South China, which have complex hydrogeological conditions and are serious disasters from mine water. The basic characteristics of hydrogeology were analyzed and the technical methods of protecting against mine water were presented. (See also W88-01408) (Author's abstract)
W88-01412

SIGNIFICANCE OF STRUCTUROLOGICAL INVESTIGATIONS IN DEFINING OF POSSIBLE DIRECTIONS OF INFLOW OF GROUND WATER INTO UNDERGROUND MINING WORKS,
Belgrade Univ. (Yugoslavia). Faculty of Mining and Geology.
For primary bibliographic entry see Field 8E.
W88-01413

SOURCE OF GROUNDWATER ENTERING COLLIERIES BENEATH RESERVOIRS,
Broken Hill Pty Co. Ltd., Wollongong (Australia). Steel Div. Collieries.
R. G. Wilson.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 59-68, 5 fig, 1 tab, 7 ref.

Descriptors: *Groundwater movement, *Coal mining, *Mine drainage, *Surface-groundwater relations, *Groundwater, Reservoirs, New South Wales, Australia, Tracers, Algae, Monitoring, Geohydrology.

Some coal mines in New South Wales, Australia, operate beneath reservoirs of the Sydney water supply. Special conditions are imposed upon mining beneath these reservoirs, although historically, entry of water into these coal mines is minor. Dykes and faults normally have no effect. Groundwater systems are maintained even when major fractures appear on the surface over areas of full extraction. In one coal mine investigations were undertaken to prove or disprove that a reservoir is the source of a water inflow. Chemical analyses of the water showed only little changes which are different from those of the reservoir. A tracer technique involved the detection of algae in the mine water. Alternative sources of algae are via the mine entrance by piped water, the ventilation system and mine traffic. In an another colliery, a proposed extension extension of workings beneath a reservoir is under consideration. Accurate surveys of surface subsidence and monitoring of the behavior of groundwater in bores were undertaken. The monitoring to date shows that the reservoir is not suffering any loss to the groundwater regime or to the mine workings. (See also W88-01408) (Author's abstract)
W88-01414

MINIMIZING WELL LOSSES IN DEWATERING WELLS IN FRACTURED ROCK,
Memorial Univ. of Newfoundland, St. John's. Dept. of Earth Sciences.
For primary bibliographic entry see Field 4B.
W88-01415

DEVELOPMENT OF AN OPEN PIT COAL MINE DEWATERING PLAN IN CESAR DEPARTMENT, COLOMBIA, S.A.,
Independent Consultants, Denver, CO.
For primary bibliographic entry see Field 4B.
W88-01416

DRAINAGE OF MINING DEVELOPMENT IN A NEOGENE LIGNITE DEPOSIT IN HUNGARY,
Technical Univ. of Heavy Industry, Miskolc (Hungary).
For primary bibliographic entry see Field 4B.
W88-01419

HYDROGEOLOGY AND DRAINAGE OF COPPER-COBALT MINES IN THE KOLWEZI AREA OF SHABA, REPUBLIC OF ZAIRE,
Hydro-Geo Consultants, Golden, CO.
For primary bibliographic entry see Field 4B.
W88-01420

PLANNING AND REALIZATION OF A CONSTANTLY INCREASING PREVENTION SYSTEM AGAINST UNDERGROUND WATER IN MINES,
Borsod Coal Mining Co., Miskolc (Hungary).
For primary bibliographic entry see Field 4B.
W88-01421

INVESTIGATION OF THE HYDROGEOLOGICAL PROBLEMS IN SOME MINES IN INDIA,
Central Ground Water Board, Lucknow (India).
B. D. Pathak.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 181-189, 4 ref.

Descriptors: *Groundwater management, *Mine drainage, *Groundwater movement, Copper mining, India, Coal mining, Case studies, Geohydrology, Safety, Hazards, Confined aquifers, Aquifers, Groundwater storage, Artesian pressure.

An accurate knowledge of groundwater flow into a working mine is essential for the planning of safe mine operations. The salient features and results of investigations on different groundwater problems in three selected coal mines in India are presented. The studies in the copper ore mines in Khetri Cooper Project, Jhunjhunu district, and Rajasthan indicated that due to the slow movement of groundwater in the mine area, conditions do not exist for sudden inundation of mines through the fracture systems. Rather, caving of water stored solution cavities in dolomites and old slopes may cause inundation depending on the size and extent of the caverns. The problem of groundwater inrush in a few selected coal mine areas from Chandrapur-Wardha coalfields was investigated. Hydrogeological investigations in the Panandhro lignite field, Gujarat, indicated that in order to control the artesian pressure of the confined aquifer in this lignite field effectively for safe mining, it is necessary to construct a well field consisting of three wells, each with a discharge capacity of 10,000 cu m/day. (See also W88-01408) (Author's abstract)
W88-01423

INFLUENCE OF GROUNDWATER PRESSURE ON MINE SLOPE STABILITY ANALYSIS,
Nottingham Univ. (England). Dept. of Community Health.
B. Denby, and M. J. Scoble.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 191-202, 5 fig, 15 ref.

Descriptors: *Slope stability, *Geohydrology, *Groundwater pressure, *Mine slope design, *Mathematical equations, Shear stress, Stress, Groundwater management, Water control, Mine drainage, Data interpretation, Strength, Mathematical analysis, Slope design, Back-analysis.

The relationships between material shear strength and groundwater pressures are examined in the context of mine slope design. Problems concerning the incorporation of shear strength and groundwater pressure data into existing stability assessments are discussed. In particular, a major hindrance to the mine slope designer is the lack of quantitative groundwater pressure data with which to work. Distinctly non-linear shear strength behavior observed for the constituent slope materials also complicates stability assessment. A new approach to this problem is outlined and proposed as an effective slope design tool which accounts for some of the uncertainties in these parameters. The technique of back-analysis as an aid to slope design is also discussed. (See also W88-01408) (Wood-PTT)
W88-01424

ROLE OF POREWATER PRESSURE AND SEEPAGE FORCES ON THE STABILITY OF PROTECTION LAYERS,
Geoloski Zavod SRS, Ljubljana (Yugoslavia).
For primary bibliographic entry see Field 8E.
W88-01425

IMPORTANCE OF PROTECTION THE OPEN CASTS FROM UNDERGROUND AND SURFACE WATER CONCERNING SLOPE STABILITY ASPECTS,
M. Ratkovic-Vujic, T. Todorovic, and S. Vujic.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 215-220, 4 fig, 2 ref.

Descriptors: *Slope stability, *Groundwater, *Surface water, *Coal mining, Safety, Hazards, Slopes, Mathematical equations, Mathematical studies.

During exploration of coal mining areas, drainage is essential. Some aspects of exploration are dependent on a reliable protection system since geomechanical properties such as slope stability, bearing capacity, adhesiveness and digging resistance are affected by the presence of underground or surface water. The influence of groundwater and surface water on slope stability were explored and appropriate mathematical equations were derived. (See also W88-01408) (Wood-PTT)
W88-01426

ORIGIN AND PROCESS CONTROL OF WET ROCK MATERIAL INRUSHES,
Central Inst. for Mining Development, Budapest (Hungary).
For primary bibliographic entry see Field 8E.
W88-01430

HYDROGEOLOGICAL ASPECTS OF GROUNDWATER HAZARD IN POLISH UNDERGROUND MINING,
Academy of Mining and Metallurgy, Krakow (Poland). Inst. of Hydrogeology and Engineering Geology.
For primary bibliographic entry see Field 4B.
W88-01431

CONTROL OF WATER IN UNLINED MINE SHAFTS AND TUNNELS,
Carleton Univ., Ottawa (Ontario). Inst. of Civil Engineering.
For primary bibliographic entry see Field 4B.
W88-01432

TECHNIQUE OF FLOWMETERING INVESTIGATIONS AT INTERVALS IN GROUT HOLES,
STG Specialized Association, Antratsit (USSR).
For primary bibliographic entry see Field 7B.
W88-01441

WATER BALANCE MODEL OF THE TRANSDANUBIAN MOUNTAIN RANGE IN HUNGARY FOR MINING PURPOSES,
Hungarian Aluminium Corp., Budapest.
T. Bocker.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 433-442.

Descriptors: *Groundwater, *Geohydrology, *Dewatering, *Coal mining effects, *Water quantity management, *Hydrologic budget, *Water demand, *Karst, *Model studies, Data interpretation, Hungary, Mine drainage, Drainage, Bauxite, Mineral industry, Statistics, Water use, Prediction, Mathematical equations.

The Transdanubian Mountain Range (TMR) is called the 'industrial shaft' of Hungary. The most important bauxite and coal mines are situated in this region. More than 50% of bauxite and coal resources are found under the karst water level so the danger of karst water inrushes into the mines is very high. Since karst water of good quality is as valuable as the bauxite and coal mineral resources and the environmental impacts of dewatering are high, a water balance model was developed to: (1) study the influence of mine dewatering of the karst system, (2) weigh the uses of the karst water

resources, and (3) forecast the future impact of karst water intake. Appropriate mathematical equations are presented for various elements of water balance including infiltration, discharge, water level, porosity, permeability, hydrologic connections of karst and other types of groundwater, and precipitation. The water balance model of the TMR is based on simple algorithms. The results of field tests showed that the model characterized the water situation of the area well. Therefore, the model can be used to design a reasonable karst water use plan for the area, and determine the effects of mine dewatering on the environment. (See also W88-01408) (Wood-PTT)
W88-01445

UNCONFINED NON-DARCY FLOW NEAR OPEN-PIT MINES,
New South Wales Univ., Kensington (Australia). Water Research Lab.
C. R. Dudgeon.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 443-454, 5 fig, 1 tab, 3 ref.

Descriptors: *Groundwater movement, *Open-pit mines, *Nondarcy flow, *Groundwater, *Mathematical equations, Darcys Law, Data interpretation, Aquifers, Flow equations, Flow, Field tests, Aquifers.

Non-Darcy flow can cause significant reductions in groundwater flows into open-pit mines in very permeable aquifers. The variables and flow equations which govern non-Darcy flow tq open pits are discussed and the computation of a set of dimensionless curves designed to facilitate the predictions of non-Darcy flow effects is described. Examples of the curves are given. Two sets of field data which indicate non-Darcy flow over distances of tens of meters from pit boundaries are presented. (See also W88-01408) (Author's abstract)
W88-01446

TWO-DIMENSIONAL NUMERICAL MODELLING OF INFLOWS TO A DRIFT THROUGH MULTILAYERED PERMEABILITY GROUND,
Birmingham Univ. (England). Dept. of Geological Sciences.
M. G. Edwards.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 455-466, 8 fig, 2 tab, 5 ref.

Descriptors: *Groundwater movement, *Drift inflows, *Computer models, *Mine drainage, *Model studies, Data interpretation, Flow, Mathematical equations, Coal mining, Finite difference methods, Permeability.

Digital computer finite-difference models were developed to investigate steady-state inflows to a drift under construction. While it is accepted that totally adequate representation of drift inflows may only be achieved through use of three-dimensional flow models, the preliminary work described employed two-dimensional and radial models to approximate the problem. Both approximations were used to analyze flows toward a drift at different levels of construction in a sequence representative of the multilayered character of the coal-mining environment. The solutions obtained from each approximation demonstrated the essential differences in their formulation, although similar trends were identifiable. Inflow magnitude was found to be largely controlled by the permeability values of the layers in the sequence actually in contact with the open section of the drift. These permeability values were also found to strongly influence the distribution of any inflow over the sides of the open section. Provisional assessment of the validity of each approximation indicated that, of the two, the radial approximation was more likely to provide realistic inflow predictions. (See also W88-01408) (Author's abstract)
W88-01447

FINITE ELEMENT APPROXIMATION OF NONLINEAR FLOW IN POROUS MEDIA,
Universidad Politechnica de Madrid (Spain). Dept. de Calculo Numerico e Informatica.
J. E. Tenreiro, and L. F. Canals.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 467-477, 4 fig, 2 tab, 19 ref.

Descriptors: *Groundwater movement, *Nonlinear flow, *Porous media, *Mine drainage, *Finite element method, *Data interpretation, Mathematical equations, Mathematical studies, Mathematical models, Flow velocity, Flow, Hydraulic gradient, Darcys Law, Mine drainage, Flooding.

For high flow velocities through porous materials Darcy's law no longer describes the relationship between the hydraulic gradient and velocity, more general expressions are required. An expression of the exponential type was considered to formulate the steady-state nonlinear flow problem. The dependence of the media permeability with the hydraulic gradient suggested the use of Lagrangian augmented methods. An algorithm was presented which was based on both these methods and involved a discretation of the flow field into finite elements which takes into account the possible appearance of a free surface. The method was applied to the calculation of an unconfined non-Darcy flow near an open mine where a system of wells was perforated to avoid flooding the mine. (See also W88-01408) (Author's abstract)
W88-01448

WATER INFLOW PREVISION IN THE SANTA BARBARA PROJECTED MINE (LEON, ESPANA),
Adaro (E.N.) de Investigaciones Mineras S.A., Madrid (Spain).
L. A. G. Fernandez, N. C. Gratacos, P. Massal, and T. Pointet.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 479-490, 9 fig, 1 tab.

Descriptors: *Groundwater movement, *Water inflow, *Metal mining, *Mine drainage, *Feasibility studies, *Model studies, Data interpretation, Geohydrology, Santa Barbara Mine, Spain, Pumping, Economic aspects, Data acquisition, Geologic fractures, Boreholes, Mathematical models.

One of the variables that currently determines the feasibility of a new mine is the volume of water needing to be pumped out during exploitation; pumping requires the use of energy which is currently highly priced. The possibility of working the Santa Barbara Pb-Zn deposit is restricted by an unfavorable hydrogeologic position. The minerals lie within a limestone-dolomite level which is crossed by an important river near the vertical shaft of the proposed mine. The mine would be developed 400 m below the river. Given the situation, a comprehensive hydrogeologic study was carried out which included use of conventional techniques such as pumping tests, logging, rock fracturation as well as some that are new in carbonated terrains such as a water injection test using a straddle-packer system in boreholes of small diameter and great depth. By these means, a surface and vertical hydrodynamic characterization of the carbonated mass was achieved. The water inflow was calculated at various stages of exploitation by means of a mathematical model prepared for the ore deposit. (See also W88-01408) (Author's abstract)
W88-01449

PREDICTION OF FISSURE-KARST WATER INFLOWS INTO MINES BY SIMULATION,
Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Gidrogeologii i Inzhenerdoi Geologii, Moscow (USSR).
G. N. Kashkovsky.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 515-521, 3 ref.

Descriptors: *Groundwater movement, *Mine drainage, *Karst hydrology, *Model studies, *Geohydrology, Data interpretation, Karst, Geologic fractures, Dewatering, Pumping, Infiltration, Simulation, Prediction.

The prediction of water inflows into mines was carried out at a deposit composed of Paleozoic karstic carbonate rocks. Water content of the deposit depends on the following natural factors typical of karst regions: a river runoff portion being absorbed by a karst rock mass; high water content of a fissure-karst aquiferous complex; and horizontal and vertical variability in filtration properties of water-saturated rocks. These factors were taken into account in the development and substantiation of an analog model of hydrogeological conditions of the studied area under natural environmental conditions, as well as under the conditions changed by mine-working. (See also W88-01408) (Author's abstract)
W88-01452

ESTIMATING WATER OUTFLOW RATE OF THE BEDROCK SECTION IN MINE SHAFTS USING HYDROGEOLOGICAL ANALYSIS METHOD,
Ministry of Coal Industry, Beijing (China).
Z. Rongxiu.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 531-539, 1 tab.

Descriptors: *Groundwater movement, *Geohydrology, *Bedrock, *Mine drainage, Prediction, Data interpretation, Hydrogeological Analysis Method, Geologic formations, Estimating, Projections, Coal mines, China, Geohydrology, Mining engineering, Flow discharge, Flow profiles.

A method of estimating the water outflow rate from the bedrock section of mine shafts was presented which was based on the careful analysis of data gathered from more than 70 pitshafts of about a dozen coalfields in China. The characteristics of water outflow rate of the bedrock section of mine shafts under different hydrogeological conditions were described. Weak points of the existing methods of predicting water outflow rate and advantages of the proposed method were pointed out. The suggested hydrogeological analysis method for estimating the water outflow rate from the bedrock sections of mine shafts was detailed. (See also W88-01408) (Author's abstract)
W88-01454

NUMERICAL CALCULATION OF GROUNDWATER INFLOW TO LONGWALL COAL FACES,
Nottingham Univ. (England). Dept. of Community Health.
R. N. Singh, S. Hibberd, and R. J. Fawcett.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 541-552, 7 fig, 2 tab, 13 ref.

Descriptors: *Groundwater movement, *Coal mines, *Mine drainage, *Geohydrology, Mathematical studies, Numerical analysis, Long wall coal faces, Flow discharge, Anisotropy, Rock properties, Data interpretation, Rocks, Coal mining, Seepage.

Numerical calculations of groundwater inflow to longwall coal faces through heterogeneous anisotropic rock strata using the boundary element method are described. The influence of mining induced changes in conductivity is investigated. The effect of a protective layer of intact rock between damaged strata and water-bearing strata is examined. Results are supported by diagrams of Darcy seepage velocities. (See also W88-01408) (Author's abstract)
W88-01455

APPLICABILITY OF CURRENT GROUNDWATER THEORIES FOR THE PREDICTION OF WATER INFLOWS TO SURFACE MINING EXCAVATIONS,
Nottingham Univ. (England). Dept. of Mining Engineering.
R. N. Singh, S. A. Ngah, and A. S. Atkins.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 553-569, 9 fig, 4 tab, 20 ref.

Descriptors: *Groundwater movement, *Mine drainage, Groundwater, Surface mines, Drawdown, Prediction, Data interpretation, Water table, Mathematical studies, Mathematical equations, Aquifer characteristics, Permeability coefficient.

Surface mining below the local groundwater table invariably results in the drawdown of the water table or piezometric surface and a corresponding flow of groundwater into the mining excavation. Accurate design of the resulting mine drainage scheme requires the prediction of inflow rate and quantity. Idealized hydrogeological profiles are presented for some surface mining situations regarding inflow prediction. Simple flow equations deriving directly from groundwater theorems are presented. Their suitability for inflow prediction is assessed. The equations fall into two groups on the basis of approach - the equivalent well method and the two dimensional flow method. Input parameters in each case are the pit geometry and aquifer characteristics. Example computations show that inflow rate depends on the site geology which determines the aquifer types, the configuration of the hydraulic conductivity contrasts and hence the flow regime. (See also W88-01408) (Author's abstract)
W88-01456

SIMULATION OF MINE DRAINAGE OF OIL-SHALE DEPOSITS, PICEANCE BASIN, COLORADO, U.S.A.,
Geological Survey, Denver, CO.
O. J. Taylor.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 571-577, 4 fig, 5 ref.

Descriptors: *Mining effects, *Mine drainage, *Simulation, *Mathematical models, *Groundwater movement, *Oil shale, *Piceance Basin, Colorado, Oil industry, Mineral industry, Finite difference methods, Data interpretation, Model studies, Dawsonite, Nahcolite, Geohydrology, Aquifers, Groundwater.

The Piceance basin of northwestern Colorado contains large quantities of oil shale and the associated minerals dawsonite and nahcolite. The extensive oil-shale deposits also are fractured-rock aquifers. Natural recharge from precipitation moves through the aquifers and is discharged to streams and springs. Planned mineral development will require mine drainage at most sites. Several mathematical models were prepared previously to simulate the impact of mine drainage on the complex geohydrologic system. A revised and improved version of the three-dimensional five-layer finite-difference model simulates streams and springs as head-dependent nodes. This model is used to simulate the reduction and cessation of natural discharge in response to mine drainage. Results of simulation studies of the hydrologic system of the entire basin indicate that the effects of mine drainage will depend greatly on the extent of mineral development. (See also W88-01408) (Author's abstract)
W88-01457

APPLICATION OF COMPUTER MODELING FOR THE DESIGN OF OPEN PIT MINE DEWATERING,
Hydro-Geo Consultants, Golden, CO.
For primary bibliographic entry see Field 4B.
W88-01458

METHOD FOR WATER RESOURCES EVALUATION FOR PREDICTION OF MINE WATER INFLOWS AND FOR COMPREHENSIVE UTILIZATION OF MINE WATER,
Academia Sinica, Beijing (China). Inst. of Geology.
Z. Cai, and H. Shi.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 599-603, 1 tab.

Descriptors: *Groundwater movement, *Mine drainage, *Water resource evaluation, *Mathematical studies, Data interpretation, Groundwater, Aquifers, Water circulation, Prediction, Aquifer characteristics, Groundwater storage, Storage capacity, Storage, Mathematical equations.

A method, based on the analysis of the circulation and renewal of water, is proposed for water resources evaluation for the prediction of mine water inflows and for comprehensive utilization of mine water. Mathematical relationships were determined for various aquifer characteristics including storage capacity (V), groundwater resources, and age of the groundwater (t); for an artesian aquifer, groundwater resources are equal to the ratio of V to t. Examples for water resources evaluation by the proposed method are given and compared with the results obtained by other methods. The advantage of the proposed method is that the parameters for the calculations, V and t, are regionally synthetic which overcomes the main difficulty of many other methods in which local parameters are poorly represented due to nonuniformity. Appropriate mathematical relationships and derivations are presented. (See also W88-01408) (Wood-PTT)
W88-01459

2G. Water In Soils

SIMULATION STUDY OF THE RECESSION COEFFICIENT FOR ANTECEDENT PRECIPITATION INDEX,
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
B. J. Choudhury, B. J. Blanchard, and C. W. Richardson.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 69-71, 3 fig, 8 ref.

Descriptors: *Hydrometeorology, *Soil water, *Simulation analysis, *Antecedent Precipitation Index, *Recession coefficient, *Mathematical studies, API, Model studies, Mathematical equations, Evapotranspiration.

The antecedent precipitation index (API) has been a useful indicator of soil moisture conditions for watershed runoff calculations. Recent attempts to correlate this index with spaceborne microwave observations have been fairly successful. This study shows that the prognostic equation for soil moisture used in some of the atmospheric general circulation models (GCM) together with Thornthwaite-Mather parameterization of actual evapotranspiration leads to API equations. The recession coefficient for API is found to depend on climatic factors through potential evapotranspiration and on soil texture through the field capacity and the permanent wilting point. Climatological and daily weather data for Wisconsin are used to simulate the annual trend and day-to-day fluctuations of the recession coefficient. Good quantitative agreement is shown with the observed trend at Fennimore and Colby watersheds in Wisconsin. This study suggests that API could be a unifying vocabulary for watershed and atmospheric general circulation modelers. (See also W88-01203) (Author's abstract)
W88-01214

RELATIONSHIP OF ANTECEDENT FLOW RATE TO STORM HYDROGRAPH COMPONENTS,
Pennsylvania State Univ., University Park. School of Forest Resources.
J. A. Lynch, and E. S. Corbett.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 73-77, 5 fig, 1 tab, 1 ref.

Descriptors: *Antecedent flow rate, *Storm water, *Hydrographs, *Soil water, *Hydrometeorology, *Rainfall-runoff relationships, Simulation analysis, Irrigation, Simulated rainfall, Flow profiles.

The importance of antecedent flow rate (AFR) as an index of soil moisture conditions on a forested watershed was quantitatively evaluated and relationships between AFT and individual storm hydrograph components were developed. The relationship between AFR and antecedent soil moisture (ASM) was also obtained. This study was carried out using a simulated rainfall facility installed on a 19.59-acre watershed. The irrigation system consisted of 5 miles of aluminum and plastic pipe and utilized 520 rotating sprinklers mounted on 5-foot risers. Water pumped from a nearby lake was used as the source for the simulated rainstorms. Eight, 1.50 inch storms were replicated at various AFR and ASM conditions. Rainfall intensity was 0.24 inches/hr. Quickflow, total storm runoff, peakflow, time of recession, and duration of quickflow resulting from these rainstorms were significantly correlated with AFR. Time to peakflow was not significantly correlated with AFR. AFR was an excellent index of ASM. (See also W88-01203) (Author's abstract)
W88-01215

NATURAL ACIDITY OF WATERS IN PODZOLIZED SOILS AND POTENTIAL IMPACTS FROM ACID PRECIPITATION,
Colorado State Univ., Fort Collins. Dept. of Earth Resources.
For primary bibliographic entry see Field 5B.
W88-01250

SEEPAGE POWER AS A FACTOR DETERMINING THE PIPING AND SILTING UP THE LOOSE WATER-BEARING SOILS,
Glowny Inst. Gornictwa, Katowice (Poland).
M. Rogoz.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 221-229, 3 fig, 5 ref.

Descriptors: *Soil water, *Seepage, *Soil mechanics, *Noncohesive soils, *Soil erosion, Seepage force, Soil physics, Piping, Pores, Silting, Permeability coefficient, Hydraulic gradient, Mathematical equations.

Water seeping through non-cohesive soils exerts a dynamic pressure, known as the seepage force, on the soil skeleton. This force, acting along the seepage path, does work which is partly converted into heat and partly used for piping the water-bearing soil. The relationship between the amount of work used for piping and that converted into heat is a function of the seepage power, the grain composition, and the soil compactness. For any soil there exists a certain power of seepage equilibrium at which washing out or deposition of grains does not occur. Increasing the seepage power enhances the piping process, whereas decreasing it causes the deposition of fine grains in the soil pores resulting in silting up of the ground. It was proven that the seepage power is proportional to the permeability coefficient and the square of the hydraulic gradient. Washing out fine grains causes an increase in the permeability further increasing the seepage power; silting up of the ground has the opposite effect. Therefore, paths of seepage with washed grains and high permeability coefficient values develop, as well as silted zones with high small grain content and much lower permeability coefficient values. (See also W88-01408) (Author's abstract)
W88-01427

WATER EFFECT ON CHANGE OF SHEAR RESISTANCE PARAMETERS OF WORKING MEDIA,
T. Todorovic, M. Ratkovic-Vujic, and S. Vujic.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 231-239, 4 fig, 5 ref.

Descriptors: *Soil mechanics, *Shear resistance, *Soil water, *Clays, Correlation analysis, Correlation coefficient, Soil physical properties, Yugoslavia, Soil porosity, Soil types, Soil structure.

In order to correlate the water content and the shear characteristics of neogene and deluvian clay deposits, samples were taken from clay layers from an open cast location in Yugoslavia. It was found that maximum values of shearing parameters were reached at optimum water content. The degree of influence of a change of soil moisture content on

shear parameters is a function of the type of soil, mineral composition, soil structure, soil porosity, degree of compactness, soil permeability, and soil plastic properties. (See also W88-01408) (Wood-PTT)
W88-01428

2H. Lakes

HYDRODYNAMICS AND MODELING OF REREGULATION POOLS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
R. C. Berger.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report E-87-6, May 1987. Final Report. 84 p, 13 fig, 2 tab, 57 ref, 4 append.

Descriptors: *Routing, *Hydrodynamics, *Model studies, *Reregulation pools, *Dams, *Reservoirs, *WESTEX, Flow patterns, Pumped storage, Costs, Simulation analysis, Sumps, Computer models, Temperature.

A reregulation dam is used to reduce drastic flow fluctuations from main reservoir releases, usually as a consequence of hydropower operations. In a pumped-storage system, it also provides storage for subsequent pumpback to the upstream reservoir. This report describes the expected impact of the addition of a reregulation facility on the temperature regimen of the reservoir-reregulation pool system. A cost-effective method for simulating the hydrodynamics and transport in a reregulation pool is presented. The method has been coupled with a vertical one-dimensional reservoir model to simulate the hydrodynamics and transport of the reservoir-reregulation pool system. The modeling procedure for simulating the hydrodynamics and transport of the reregulation pool was selected from three candidate methods. The three methods in progressive order of complexity are: (1) the sump method; (2) the level pool routing method, and (3) the finite difference simulation of the Saint-Venant equations. The methods have been incorporated within the WESTEX model, and the predicted temperature profiles in the main reservoir and the release temperatures from the reregulation pool are compared to results from a reservoir study previously conducted at the Waterways Experiment Station. The longitudinal resolution of the level pool routing and the Saint-Venant simulation methods allow a more realistic response to temperature fluctuations then can be provided by the sump method. Further, the level pool routing method gives results comparable to the more complex Saint-Venant method in a more cost-effective manner. (Author's abstract)
W88-01055

PROCEEDINGS OF THE DEGRAY LAKE SYMPOSIUM.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report E-87-4, March 1987. Final Report. 633 p. Edited by R. H. Kennedy and Joe Nix.

Descriptors: *Reservoirs, *Conferences, *DeGray Lake, *Symposia, *Arkansas, *Limnology, Geohydrology, Water quality, Model studies, Biological studies, Chemical analysis, EWQOS.

The Environmental and Water Quality Operational Studies (EWQOS) Program, a major water quality research program funded by the Office of the Chief, US Army Corps of Engineers (CE), and conducted by the US Army Engineer Waterways Experiment Station, was designed to assess the relations between design, construction, and operation of Civil Works projects and exhibited water quality characteristics, and to develop and demonstrate technological means for ameliorating water quality problems in a manner compatible with project purposes. An important aspect of the EWQOS Program was the conduct of comprehensive studies of water quality processes in reservoirs. These studies involved both long-term and short-term limnological evaluations of four characteristic CE reservoirs. DeGray Lake, located in south-central Arkansas, was studied during the period 1967-1982. Research activities ranged from evaluations of geologic and hydrologic processes, to studies of complex biological, chemical, and physical processes influencing water quality, to the development of water quality models. A symposium was held to provide a forum for the exchange of information and ideas and an opportunity to synthesize these data in ways that will lead to a greater understanding of DeGray Lake, in particular, and of reservoir limnology, in general. Information gathered as a result of these studies and discussed herein will broaden the understanding upon which sound strategies for managing these valuable resources must be based. This report documents information presented at the symposium. (See W88-01057 thru W88-01082) (Author's abstract)
W88-01056

DESIGN, CONSTRUCTION, AND OPERATION OF DEGRAY LAKE,
Army Engineer District, Vicksburg, MS.
For primary bibliographic entry see Field 8A.
W88-01060

MATERIAL LOADING TO DEGRAY LAKE, ARKANSAS: PATTERNS AMONG VARIABLES AND SIGNIFICANCE OF STORM EVENT LOADING,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
R. H. Montgomery.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 128-167, 8 fig, 17 tab, 28 ref.

Descriptors: *Material loading, *DeGray Lake, *Limnology, *Reserviors, *Arkansas, *Storms, Water quality, Biological studies, Chemical analysis, Statistical methods, Data interpretation, Model studies, Mathematical models.

The physical, chemical, biological, and social characteristics of reservoir ecosystems are directly controlled by the input of material from external sources. Nutrients, such as phosphorus, nitrogen, carbon, and silica, control algal and macrophyte growth, which in turn affect the higher levels in the food chain. The link between the input of nutrients and reservoir productivity has resulted in efforts to relate nutrient loads to the level of lake eutrophication. The rate of allochthonous sediment input directly controls the rate of depletion of reservoir storage capacity. The chemical composition of input particulate matter affects lake sediment characteristics and water clarity which govern the benthic community, internal loading during periods of anoxia, and reservoir water quality. Material loading may also cause longitudinal gradients in water quality and sediment characteristics. Since material loads have such a significant impact on reservoir systems, accurate quantification of material loads is essential. Discussed here are the four different types of estimators of material loading to a lake: (1) zero-order, (2) direct, (3) statistical, and (4) descriptive. The zero-order method utilizes loading estimates from either the same, or a similar, watershed obtained from a previous study or uses export coefficients as a function of land use. The direct method uses routine water quality data and discrete or instantaneous flow data to calculate loads. Statistical methods use correlation and regression analyses to develop stochastic models for predicting concentration and/or load from a set of independent variables. Descriptive methods employ deterministic mathematical models of physical, chemical and hydrological processes. (See also W88-01056) (Lantz-PTT)
W88-01061

THERMAL STRUCTURE AND CHARACTERISTICS OF DEGRAY LAKE,
Ford, Thornton, Norton and Associates Ltd., Little Rock, AR.
M. C. Johnson, and D. E. Ford.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 168-185, 20 fig, 2 ref.

Descriptors: *DeGray Lake, *Arkansas, *Thermocline, *Reservoirs, *Lakes, *Limnology, Thermal stratification, Annual variation, Synoptic analysis, Diurnal distribution, Water temperature, Hypolimnion, Seasonal variation, Model studies.

The temporal variations in thermal structure at DeGray Lake can be characterized at three levels: annual, synoptic, and diurnal. On an annual basis, overturn occurs in late January or early February with the onset of stratification in March. The minimum thermocline depth occurs near summer solstice. Surface temperatures peak nearly two months later, however. The hypolimnetic temperature is determined by temperatures during the previous winter and increases little during the year. Inflows and outflows from March through May are large and augment wind mixing in defining the thermal structure of the reservoir. Synoptic events occur over several days but their cumulative effects determine the thermal structure of the reservoir. Large inflows and outflows occur in March through May as a result of synoptic events and increase mixing within the pool. Diurnal variations are strongly influenced by solar radiation. During the summer, diurnal variations generally result in a net gain in heat and during the fall, a net loss. Even though diurnal temperature variations within the pool and inflow are small they are, non-the-less, important to consider when interpreting field data or modeling results. (See also W88-01056) (Lantz-PTT)
W88-01062

MIXING PROCESSES IN DEGRAY LAKE, ARKANSAS,
Ford, Thornton, Norton and Associates Ltd., Little Rock, AR.
D. E. Ford.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 186-205, 10 fig, 5 ref.

Descriptors: *Reservoirs, *DeGray Lake, *Arkansas, *Limnology, *Mixing, *Advection, *Convection, *Diffusion, *Dispersion, Destratification, Entrainment, Shear, Hydrometeorology, Thermal stratification.

Mixing processes are defined as any mechanism that causes a parcel of water to blend with or be diluted by another parcel of water. Understanding and quantifying these mixing processes are essential to understanding the observed water quality of DeGray Lake since they control the movement and dilution of many water quality constituents. Specific mixing processes include advection, convection, diffusion, dispersion, entrainment, and shear. All of these processes require energy from meteorological forcing, inflows, outflows, and/or project operation, which includes the effects of hydropower operation. The relative magnitude and importance of the individual processes depend on the time and space scales or characteristics of the forcing functions, the degree of thermal stratification, and the physical location in the reservoir. In this paper, each of the mixing mechanisms is described and quantified with respect to season and location (i.e., headwater, cove, main body near dam, and epilimnion, metalimnion, and hypolimnion). The relative significance of each process to observed water quality is also discussed. (See also W88-01056) (Author's abstract)
W88-01063

DISSOLVED OXYGEN STATUS OF DEGRAY LAKE, ARKANSAS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
R. H. Kennedy, and J. Nix.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 206-223, 7 fig, 1 tab, 15 ref.

Descriptors: *Dissolved oxygen, *DeGray Lake, *Arkansas, *Reservoirs, *Limnology, Hypolim-

nion, Oxygen demand, Organic matter, Deposition, Chemical analysis, Biological studies, Lakes.

Pronounced changes in the oxygen status of DeGray Lake have occurred in the years since impoundment. In years immediately following impoundment, the inundation of soils, vegetation and detritus led to high oxygen demands and the extensive loss of oxygen from the hypolimnion. As readily oxidizable organic materials were depleted, oxygen conditions in the hypolimnion and allochthonous organic materials has played a greater role in the lake's oxygen dynamics. Of particular importance is the deposition of organic materials in the headwater of the lake and the seasonal occurrence of anoxia in the shallow hypolimnion in this region of the lake. These changes are of significance in understanding other chemical and biological occurrences in the lake. Observations reported here also provide information of general importance in the understanding of events occurring in newly filled reservoirs. (See also W88-01056) (Lantz-PTT)
W88-01064

NUTRIENT DYNAMICS IN DEGRAY LAKE, ARKANSAS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
R. H. Kennedy, and J. Nix.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 224-235, 5 fig, 1 tab, 11 ref.

Descriptors: *Nutrients, *DeGray Lake, *Arkansas, *Reservoirs, *Cycling nutrients, *Limnology, Nitrogen, Phosphorus, Organic matter, Seasonal variation, Lakes, Caddo River.

Important changes in the relative influences of various processes on the dynamics of nitrogen and phosphorus have occurred during the period following impoundment of DeGray Lake. Nitrogen inputs from the watershed have remained relatively constant, while the importance of nitrogen sources within the lake has diminished over time coincident with declines in the quantity of oxidizable organic material inundated during initial filling. Phosphorus concentrations, while also initially influenced by the inundation of terrestrial material, are now regulated to a greater extent by interactions with iron and by seasonal changes in oxygen status. Events of greatest impact on phosphorus dynamics are those occurring in the headwater area of the lake. It is here that external phosphorus loads are initially stored in sediments and later recycled during periods of anoxia. Since this coincides with the period of minimal phosphorus loading from the Caddo River, recycling from bottom sediments plays a potentially important role in determining the trophic status of this lake. (See also W88-01056) (Lantz-PTT)
W88-01065

DISTRIBUTION OF IRON AND MANGANESE IN DEGRAY RESERVOIR, ARKANSAS,
Ouachita Baptist Univ., Arkadelphia, AR.
J. Nix.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 236-257, 9 fig, 1 tab, 14 ref.

Descriptors: *Cycling nutrients, *DeGray Lake, *Arkansas, *Reservoirs, *Iron, *Manganese, *Limnology, Chemical analysis, Lakes, Stratification, Metals, Dissolved oxygen, Advection, Mixing.

Although the cycling of iron and manganese in DeGray can generally by explained by the same processes that occur in most seasonally anoxic lakes, it is necessary to impose processes which seem to be characteristic of deep reservoir systems to adequately explain the distribution of these metals in DeGray Reservoir. The solubilization of iron and manganese clearly begins in the upstream section of the hypolimnion and progresses into the downstream hypolimnion throughout the period of stratification. As expected, manganese generally appears first and extends further into the reservoir than iron. The observation that elevated concentrations of these metals do not generally begin to appear in the water column until the low dissolved oxygen zone develops near the bottom strongly suggests that the origin of both iron and manganese is bottom sediments. Advective transport by a density current near the top of the metalimnion results in the entrainment of upstream hypolimnetic water and ultimate transport of reduced species into the downstream metalimnion of the reservoir. This process can result in the preferential transport of manganese over iron through the reservoir system. The presence of elevated concentratiens of reduced species in the metalimnetic regions of reservoirs should be given consideration in the design of the intake structures to be used by municipalities and industries. (See also W88-01056) (Lantz-PTT)
W88-01066

LONG-TERM PHYTOPLANKTON SUCCESSION IN DEGRAY RESERVOIR (1975-1980),
Arkansas Univ., Fayetteville. Dept. of Botany and Microbiology.
R. L. Meyer.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 258-273, 7 fig, 2 tab, 9 ref.

Descriptors: *DeGray Lake, *Arkansas, *Reservoirs, *Phytoplankton, *Limnology, Seasonal variation, Chemical analysis, Biological studies, Water supply.

Annual and long-term phytoplankton succession studies on DeGray Reservoir included a regular collection program in each of the reservoir's major compartments from 1975 through 1980. Samples were collected in association with various chemical, physical, and biological studies. The data indicate distinct, but independent, temporal distribution patterns for the major taxa. Critical period analysis shows that the successional dynamics for each lake compartment were relatively distinct from adjacent compartments during the early phases but tended toward greater homogeneity. The structure of the phytoplankton assemblage as defined by the number of species per sample is described temporally for each compartment. A distinct trend from a diverse assemblage to a major single taxon dominance was observable for the summer maximum, fall transition, and to a lesser extent during the winter. The data indicate a reduction in qualitative variability with an increased abundance throughout the 5-year sampling period. (See also W88-01056) (Author's abstract)
W88-01067

USE OF EMPIRICAL PHYTOPLANKTON INDICES FOR PRETROPHIC STATE ANALYSIS,
W. L. Poppe.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 274-296, 2 tab, 3 ref.

Descriptors: *Phytoplankton, *Empirical analysis, *Trophic level, *Lakes, *DeGray Lake, *Reservoirs, *Limnology, *Model studies, Mathematical studies, Water sampling, Lakes, Biological studies, Model studies.

Examined and qualified here is one facet of preeutrophication analysis: phytoplankton indices. Sorenson's quotient and Pielou's similarity index are used to describe similarities and differences within and among stations, both temporally and spatially. The results of these analysis indicate that very few similarities exist within DeGray Reservoir, which implies that these analyses alone are of little use in describing the phytoplankton quality of the reservoir. These analyses do however, merit use and suggest that a modification of plankton sampling will be required to obtain 'average' conditions for modeling purposes. (See also W88-01056) (Author's abstract)
W88-01068

SIZE DISTRIBUTION OF PLANKTONIC AUTOTROPHY AND MICROHETEROTROPHY IN DEGRAY RESERVOIR, ARKANSAS,
Oak Ridge National Lab., TN. Environmental Sciences Div.
B. L. Kimmel, and A. W. Groeger.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 297-326, 7 fig, 1 tab, 73 ref. DOE Contract No. W-7405-eng-26.

Descriptors: *Plankton, *DeGray Lake, *Arkansas, *Reservoirs, *Size distribution, *Autotrophy, *Heterotrophy, *Limnology, Carbon radioisotopes, Sodium bicarbonate, Caddo River, Algae, Lakes, Bacterioplankton.

Naturally occurring assemblages of phytoplankton and bacterioplankton were radiolabelled with sodium 14-C-bicarbonate and sodium 3-H-acetate and size fractionated to determine the size structure of planktonic autotrophy and microheterotrophy in DeGray Reservoir, an oligotrophic impoundment of the Caddo River in south-central Arkansas. Size distributions of autotrophy and microheterotrophy were remarkably uniform seasonally, vertically within the water column, and along the longitudinal axis of the reservoir despite significant changes in environmental conditions. Planktonic autotrophy was dominated by small algal cells with usually $>$ 50% of the photosynthetic carbon uptake accounted for by organisms $<$ 8.0 micrometers. Microheterotrophic activity in the 0.2 to 1.0 micrometer size fraction, presumable associated with free-living bacterioplankton not attached to suspended particles, usually accounted for $>$ 75% of the planktonic microheterotrophy. Longitudinal patterns in autotrophic and microheterotrophic activities associated with $>$ 3 micrometer and 1 micrometer size fractions, respectively, suggest an uplake to downlake shift from riverine to lacustrine environmental influences within the reservoir. (See also W88-01056) (Author's abstract)
W88-01069

SPATIAL AND SEASONAL PATTERNS OF PHOTOSYNTHETIC CARBON METABOLISM IN DEGRAY LAKE PHYTOPLANKTON,
A. W. Groeger, and B. L. Kimmel.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 327-350, 8 fig, 2 tab, 24 ref. DOE Contract No. W-7405-eng-26.

Descriptors: *Spatial distribution, *Seasonal variation, *Photosynthesis, *Carbon metabolism, *DeGray Lake, *Phytoplankton, *Arkansas, *Reservoirs, *Limnology, Carbon, Vertical distribution, Polysaccharides, Nitrogen, Lakes, Light intensity.

Flow of recently assimilated carbon into intracellular macromolecular pools was used to assess the physiological state of the phytoplankton community in DeGray Lake during September 1982 and February and June 1983. Patterns from both vertical profiles and along the longitudinal axis of the reservoir were examined. Phytoplankton responded to increasing light intensities by sequestering more carbon into polysaccharides. Within the lacustrine zone of the reservoir, which usually extended uplake from the dam at least 25 to 30 km along the river channel, the phytoplankton were in a similar physiological state and, during June and September, showed carbon allocation patterns characteristic of nutrient deficiency. High percentages of carbon flowing into lipid production and the results of other nutrient deficiency assays suggest that phytoplankton productivity was nitrogen limited in the lacustrine zone of DeGray Lake in June 1983. (See also W88-01056) (Author's abstract)
W88-01070

SPATIAL AND TEMPORAL DISTRIBUTION OF ZOOPLANKTON IN DEGRAY RESERVOIR, ARKANSAS,
Aquatic Ecosystem Analysts, Fayetteville, AR.
J. I. Meinecke, G. R. Ploskey, L. Aggus, S. M. Heinrichs, and R. Roseberg.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 351-367, 21 fig, 25 ref. USFWSC BSFW 14-16-0008-2073 and BSFW 14-16-0009-77-051 and ACEC DACW39-78-C-0067.

Descriptors: *Limnology, *Zooplankton, *DeGray Lake, *Reservoirs, *Arkansas, *Spatial distribution, *Temporal distribution, Stratification, Lakes, Temperature, Dissolved oxygen, Quantitative analysis, Qualitative analysis, Mathematical studies, Hypolimnion.

Vertical, stratified zooplankton samples were taken at monthly intervals from six selected stations in DeGray Reservoir during 1976-81. Temperature, specific conductance, dissolved oxygen concentration, and Secchi disk transparency also were monitored during each sampling period. Qualitative and quantitative analyses of zooplankton samples included identification, enumeration, and dry weight determinations. Data were standardized and analyzed using one-way analyses of variance and Duncan's Multiple Range Test. Total zooplankton concentrations were greatest at up-lake stations, but minimal in the uppermost riverine location. Concentrations of entomostracans at up-lake stations only during summer months. Dry weight values were more uniform among stations than were concentration values, except for contrastingly low values at the uppermost riverine station. Zooplankton concentrations of entomostracans corresponded to this unimodal pattern to account for the spring peak in total dry weights, but rotifers displayed a trimodel abundance pattern. The greatest zooplankton concentrations, as well as the highest dry weight values, were recorded in 1980. Effects on zooplankton assemblages of changing to a hypolimnial from an epilimnial release mode were not clearly apparent. (See also W88-01056) (Author's abstract)
W88-01071

BACTERIAL INDICATORS OF WATER QUALITY FROM SOUTHWEST ARKANSAS RESERVOIRS: DEGRAY LAKE,
Henderson State Univ., Arkadelphia, AR.
J. D. Bragg.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 368-396, 20 fig, 2 tab, 16 ref.

Descriptors: *Water quality, *Arkansas, *Reservoirs, *DeGray Lake, *Bacteria, *Bioindicators, *Limnology, Water analysis, Bacterial analysis, Monitoring, Storms, Coliforms, Streptococcus, Lakes.

Indicator bacteria were monitored in DeGray Reservoir, Arkansas, and its major tributaries for several years. Storms were primarily responsible for loading bacteria into the reservoir. Stratified distribution patterns developed according to thermal density gradients existing within the lake with peak densities appearing most often in the epilimnion and thermocline region. Maximum densities of bacteria were associated with storm plumes. Total coliforms decreased, and fecal coliforms and streptococci increased, during the study. These changes were significant in the upper compartment of the reservoir. Taxa isolated as total coliforms were predominantly members of the Enterobacteriaceae. Fetal coliform/fetal streptococci ratios indicated fecal contamination of non-human origin. (See also W88-01056) (Author's abstract)
W88-01072

POPULATION DYNAMICS OF THE FISHES IN DEGRAY LAKE, ARKANSAS, DURING EPILIMNIAL AND HYPOLIMNIAL RELEASE,
T. E. Moen, and M. R. Dewey.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 397-436, 2 fig, 13 tab, 45 ref.

Descriptors: *Population dynamics, *Fish, *DeGray Lake, *Arkansas, *Epilimnion, *Hypolimnion, *Reservoirs, *Limnology, Bass, Seasonal variation, Biomass, Sunfish, Crappies, Shad, Ecosystems, Lakes.

Three major methods were used in assessing the fish populations of DeGray Lake, Arkansas, during epilimnial release (1974-78) and hypolimnial release (1979-82): fish samples were collected annually with rotenone in three coves. Largemouth bass population estimates were made in three coves in April each year and mid-water trawls were used to assess young-of-the year populations and production of shad. Biomass in each cove generally declined during epilimnial release but remained relatively stable during hypolimnial discharge. Annual changes in total standing crop were largely influenced by fluctuations in shad (Dorosoma spp.) populations. A strong longitudinal gradient developed with age; the cove representing the upper lake region had the greatest total biomass each year except 1974 and showed the least year-to-year variation and smallest decline over the 9 years. Lakewide mean estimates of largemouth bass declined each year during epilimnial release, fluctuating at lower levels during hypolimnial discharge. Lakewide production of largemouth bass averaged 26.6 kg/ha during epilimnial release and 18.2 kg/ha during hypolimnial release. Shad, sunfishes (Lepomis spp.) and crappies (Pomoxis spp.) made up 98% of larval fish collected by mid-winter trawling. Densities (n/cu m) of larval sunfish were higher during epilimnial release than during hypolimnial discharge. Crappies and shad were higher during hypolimnial release. Estimates of shad production during hypolimnial release were 67% greater than during epilimnial discharge. Relationships between the environmental factors (age, water level fluctuation, outlet depth) and standing crops are discussed. (See also W88-01056) (Author's abstract)
W88-01073

ENTRAINMENT OF LARVAL FISH FROM DEGRAY LAKE, ARKANSAS, DURING EPILIMNIAL AND HYPOLIMNIAL DISCHARGES,
National Fishery Research Lab., La Crosse, WI.
M. R. Dewey, and T. E. Moen.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 437-460, 4 fig, 7 tab, 19 ref.

Descriptors: *Larval fish, *DeGray Lake, *Arkansas, *Epilimnion, *Hypolimnion, *Reservoirs, *Limnology, *Model studies, *Entrainment, Vertical distribution, Fish, Population dynamics, Regression analysis, Mathematical studies, Shad.

Vertical distribution and density of reservoir populations of fish larvae vulnerable to entrainment were related to estimated entrainment during water releases from the epilimnion and hypolimnion. Relations between larval entrainment and outlet depth, time of day, season and discharge volumes from 1976 to 1982 are described. Linear regression models were developed to predict larval loss during each type of discharge from densities of larvae immediately above the dam. The slopes of the regression equations indicated a higher degree of entrainment during epilimnial than during hypolimnial releases for all taxa. Percentages of the larvae immediately above the dam that were entrained at different densities (no./cu m) were also calculated for each taxon. These data do not indicate a response to the depth of the outlet but a passive entrainment during both epilimnial and hypolimnial discharges. The change in the outlet depth affected the entrainment of shad (Dorosoma) more than that of other taxa. Most of the entrainment percentages for shad were more than 10 times greater during epilimnial than during hypolimnial discharges. Percentages of the total reservoir larval population entrained were calculated and these indicated little impact due to entrainment during either type of discharge. (See also W88-01056) (Author's abstract)
W88-01074

PATTERNS OF SEDIMENTATION AT DEGRAY LAKE, ARKANSAS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 2J.
W88-01075

ANAEROBIC CHEMICAL RATE COEFFICIENTS OF DEGRAY LAKE,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
R. L. Chen, J. M. Brannon, and D. Gunnison.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 502-514, 3 fig, 3 tab, 15 ref.

Descriptors: *Limnology, *Reservoirs, *Model studies, *Chemical analysis, *DeGray Lake, *Arkansas, *Anaerobic conditions, Lake sediments, Oxygen, Water quality, Water chemistry.

Presented is a compilation of anaerobic release rates for DeGray Lake sediments generated using DeGray Lake sediment in large-scale laboratory reactor units. DeGray Lake annually experiences oxygen depletion in bottom waters and subsequent accumulation of anaerobic products within its hypolimnion during the stratification period. These anaerobic release processes from sediment to anoxic waters can severely downgrade water quality. Therefore, to adequately model the water chemistry of DeGray Lake, the accumulation and fate of anaerobic products must be considered. One means to accomplish this is to apply an anaerobic subroutine based on a conceptual model which has been incorporated into a comprehensive, one-dimensional reservoir water quality model (CE-QUAL-R1). This subroutine, however, has little utility if appropriate, site-specific anaerobic rate coefficients for DeGray Lake are unavailable. Although some anaerobic release rates have been reported for other aquatic environments, these rate coefficients are of limited use because of the limited numbers of compounds for which rates exist and the doubtful applicability of these rates to DeGray Lake. Correlations between anaerobic release rates and sediment characteristics are also discussed. (See also W88-01056) (Lantz-PTT)
W88-01076

HETEROGENEITIES AND WATER QUALITY - UNDERSTANDING DEGRAY LAKE WATER QUALITY THROUGH SAMPLING,
Ford, Thornton, Norton and Associates Ltd., Little Rock, AR.
K. W. Thornton.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 515-535, 7 fig, 3 tab, 14 ref.

Descriptors: *Water quality, *DeGray Lake, *Sampling, *Water sampling, *Heterogeneity, *Limnology, *Reservoirs, Temporal variation, Spatial variation, Littoral zone, Stratification, Monitoring.

Reservoir water quality exhibits temporal and spatial variability that must be considered in designing sampling or monitoring programs. Spatial variability in longitudinal, lateral, and vertical dimensions can be incorporated by considering the plunge zone, littoral area, and stratification regime, respectively. Sampling schemes should incorporate temporal variability by considering important limnological periods. Temporal variability over daily, synoptic, and seasonal time scales can be incorporated by using variable interval sampling. Quality assurance and quality control in the field are absolutely essential in any sampling program and are stressed. Since the purpose of the monitoring program is to reach conclusions from the water quality data, data analysis must be an integral part of the program. (See also W88-01056) (Author's abstract)
W88-01077

THERMAL MODELING OF DEGRAY LAKE,
Johnson Associates Water Resources Consultants, Inc., Little Rock, AR.
L. S. Johnson, and D. E. Ford.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 536-564, 15 fig, 1 tab, 6 ref.

Descriptors: *DeGray Lake, *Arkansas, *Thermal stratification, *Model studies, *Lake Greeson, *Reservoirs, *Limnology, *Temperature, *CE-THERM-R1, Lakes, Mathematical models, Computer models, Mixing, Lake morphology, Thermocline.

A one-dimensional reservoir thermal model (CE-THERM-R1) was developed to simulate the ef-

fects of reservoir operation on both the in-lake and downstream temperature regimes. During model development, emphasis was placed on formulating algorithms describing inflow mixing, selective withdrawal, and internal mixing which accurately simulate the dynamics of mixing in reservoirs. An integral energy approach was used to simulate mixed layer dynamics. The model was applied to two reservoirs of similar morphometry yet different operating strategies. The model was calibrated on one data set from DeGray Lake, AR, then verified using four other independent data sets from DeGray Lake and Lake Greeson, AR. The model was able to reproduce observed phenomena such as the onset of stratification, surface temperatures, depth of the mixed layer, density gradient in the metalimnion, and hypolimnetic temperature. (See also W88-01056) (Author's abstract)
W88-01078

TWO-DIMENSIONAL MODELING OF STORM EVENT INFLOW PROCESSES AT DEGRAY LAKE,
Ford, Thornton, Norton and Associates Ltd., Little Rock, AR.
For primary bibliographic entry see Field 2A.
W88-01079

MODELING ANAEROBIC PROCESSES IN RESERVOIRS - DEGRAY LAKE,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
M. J. Zimmerman.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 601-616, 7 fig, 1 ref.

Descriptors: *Model studies, *Reservoirs, *Anaerobic condition, *DeGray Lake, *Limnology, *Arkansas, *Anoxia, Phosphorus, Nitrogen, Manganese, Iron, Sulfur, Nutrients, Computer models, Mathematical models.

The ability to predict anoxia in reservoirs has long been a part of reservoir ecosystem models used by the Corps of Engineers (CE). However, anoxia is often associated with other unwelcome water quality effects including release from sediments of phosphorus and reduced forms of nitrogen, manganese, iron, and sulfur. Phosphorus and nitrogen serve to stimulate algal growth which may have contributed, through respiration and organic decay (oxygen-consuming processes), to the development of anoxia in the first place. Iron and manganese cause staining problems in water supplies and require added expense for their removal. Sulfur, in the form of hydrogen sulfide gas, is noxious smelling, toxic, and corrosive. Thus, the ability to predict the onset and extent of potential problem associated with anoxia or low dissolved oxygen (DO) conditions would be a valuable asset for reservoir planners and managers. This paper presents a background discussion for the development of subroutines describing biogeochemical events associated with anoxia in reservoirs. The problems in conceptualization of a new modeling approach for inclusion in an existing one-dimensional model were stressed. These difficulties arose from attempts to reconcile traditional methods of studying anaerobic processes, such as isolated chambers in laboratory situations, with more poorly defined environmental conditions where hydrodynamics and naturally varying conditions may generate unsteady conditions. Finally, modeling results are presented. Simulations demonstrating critical aspects of modeling relevant to the prediction of the onset of anoxia are described. Coefficients used are somewhat dated; i.e., the coefficients used in the simulations presented here originated from an earlier calibration study, but, since that time, corrections and improvements have been incorporated into the thermal portions of the model. In spite of these changes, the water quality simulations are still acceptable and future recalibration should improve them. (See also W88-01056) (Lantz-PTT)
W88-01080

MONITORING COLDWATER DISCHARGES FROM DEGRAY RESERVOIR USING THERMAL INFRARED IMAGERY,
Army Engineer District, Vicksburg, MS.
T. S. Smith, and R. E. Price.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 617-622, 2 fig, 3 ref.

Descriptors: *Reservoir releases, *Measuring instruments, *Monitoring, *Coldwater discharges, *DeGray Lake, *Reservoirs, *Thermal infrared imagery, Aquatic environment, Lakes, Water temperature, Hypolimnion, Infrared imagery, Thermal stratification, Mixing, Remote sensing.

The aquatic environment downstream from large reservoirs is controlled to a large extent by the reservoir releases. If the reservoir has a hypolimnial release, the discharge may be relatively cold. Reservoir release should be addressed as a whole, rather than a few one-dimensional in situ points, which may not adequately relate thermal patterns. Thermal infrared (IR) imagery (aircraft platform) was utilized to observe the relative temperature differentials. This technique revealed thermal mixing patterns (across and downstream) of DeGray Reservoir to a point several miles below the dam. (See also W88-01056) (Author's abstract)
W88-01081

RESERVOIR LIMNOLOGY: AN OVERVIEW,
Michigan State Univ., Hickory Corners. W.K. Kellogg Biological Station.
R. G. Wetzel.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 623-633, 1 tab, 10 ref. DOE Contract No. EY-76-S-02-1599, COO-1599-241.

Descriptors: *Reservoirs, *Limnology, *Reservoir management, Lakes, Ecosystems, Chemical analysis, Aquatic ecosystems.

A comparative analysis of structural and functional characteristics of reservoir and natural lake ecosystems indicated strong similarities in all functional, metabolic properties. The irregular and erratic changes in physical and certain chemical properties of reservoirs leads to a number of aborted biotic growth and development responses that result in reduce diversity, less specialization, and increased ecosystem instability in reservoirs. Based on existing knowledge, numerous reservoir management techniques could be modified to increase the biotic stability, as well as the longevity, of reservoirs. (See also W88-01056) (Author's abstract)
W88-01082

NONPOINT SOURCE POLLUTION CONTROL FUNDING FOR LAKE RESTORATION: A CASE STUDY AT CARLISLE LAKE,
Washington State Univ., Pullman. Environmental Engineering Dept.
For primary bibliographic entry see Field 5G.
W88-01108

WHY SCOFIELD RESERVOIR IS EUTROPHIC: EFFECTS OF NONPOINT SOURCE POLLUTANTS ON A WATER SUPPLY RESERVOIR IN UTAH,
Geological Survey, Salt Lake City, UT.
For primary bibliographic entry see Field 5C.
W88-01109

TROPHIC STATE RESPONSE TO NONPOINT POLLUTION CONTROL: APPLICATION OF COUPLED MICROCOMPUTER MODELS TO THE GREAT LAKES,
Michigan Technological Univ., Houghton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W88-01110

PROJECT TO MANAGE AGRICULTURE WASTES HAS IMPROVED THE QUALITY OF VERMONT'S LAKE PARKER,
Soil Conservation Service, Winooski, VT.
For primary bibliographic entry see Field 5G.
W88-01111

USE OF WETLANDS IN TREATING NONPOINT SOURCE POLLUTION,
Hickok (Eugene A.) and Associates, Inc., Wayzata, MN.
For primary bibliographic entry see Field 5G.
W88-01156

LIMNOLOGICAL STUDIES AT EAU GALLE LAKE, WISCONSIN. REPORT 2: SPECIAL STUDIES AND SUMMARY,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
R. H. Kennedy, and R. C. Gunkel.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report E-85-2, March 1987. Report 2 of a Series. 167 p, 56 fig, 15 tab, 13 ref.

Descriptors: *Eau Galle Lake, *Wisconsin, *Limnology, Dissolved oxygen, Water quality, Thermal stratification, Seasonal variation, Macrophytes, Chlorophyll, Nutrients, Phosphorus, Nitrogen.

Water quality studies were conducted at Eau Galle Lake during the period October 1980 to September 1982 as part of the Task VIIA of the Environmental and Water Quality Operational Studies Program. Specific objectives for studies at Eau Galle Lake included: the establishment of a water quality database for the calibration and verification of a mathematical model; evaluation of nutrient and metal dynamics; delineation of relations between material inputs, sedimentation, recycling, and losses by discharge; identification of factors affecting primary and secondary production; and evaluation of physical factors influencing lake dynamics. Dissolved oxygen concentrations decline in bottom waters immediately following the onset of thermal stratification (mid- to late-May), and anoxic conditions are established by early to mid-June; by July, anoxic conditions are observed at depths below 3 to 4 m. Autumnal circulation and reoxygenation of bottom waters begins in mid- to late-September and is complete by early October. A submersed aquatic macrophyte community is well established in the lake with highest plant densities occurring in shallow areas adjacent to the point of inflow of the Eau Galle River and in littoral areas of a cove located along the western shore. Chlorophyll a concentrations, an approximate measure of phytoplankton abundance, are seasonally high (maxima of 100 to 150 mg/cu m) and exhibit two annual peaks. The first, attributable to diatoms, occurs in the spring following ice-out but preceding the establishment of stable thermal stratification. The timing and magnitude of the peak are influenced to a great extent by the date of ice loss and by the occurrence and magnitude of snowmelt and runoff. Peak concentrations following ice-out in 1982, a year in which spring runoff and associated material loading was rapid and excessive, were considerably lower (25 versus 150 mg/cu m) than for the same period in 1981. (Lantz-PTT)
W88-01190

IMPROVED DESCRIPTION OF SELECTIVE WITHDRAWAL THROUGH POINT SINKS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 5G.
W88-01191

EVAPORATION TIME SERIES ANALYSIS FOR MILFORD LAKE IN KANSAS,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 2D.
W88-01216

UTILIZATION OF HYDROMETEOROLOGICAL MONITORING SYSTEMS TO ENHANCE RESERVOIR OPERATIONS DURING FLOOD EMERGENCIES,
Salt River Project, Phoenix, AZ. Water Resources Operations.
For primary bibliographic entry see Field 2E.
W88-01232

TRENDS AND EXTREMES OF LAKE ERIE WATER SUPPLIES,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
F. H. Quinn.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 267-270, 3 fig, 12 ref.

Descriptors: *Hydrometeorology, *Water-level fluctuations, *Water balance, *Water yield, *Forecasting, *Lake Erie, *Water supply, Precipitation, Runoff, Evaporation, Air temperature, Climates, Model studies, Hydrologic budget.

Lake Erie is the fourth largest of the Great Lakes with a surface area of 25,700 sq km and a land basin area of 61,100 sq km. Its water is derived from the upper Great Lakes and its own net basin supply consisting of precipitation, runoff, and lake evaporation. In this study, a data base consisting of monthly time series of air temperature, precipitation, runoff, and lake evaporation is used to examine trends and extremes in the net basin supply. This averages about 62 cm, with extremes ranging from 0.0 cm in 1934 to 145 cm in 1950. Of particular note is an apparent major change in the supplies occurring during the late 1930's. The average annual basin supplies for 1940-79 were approximately 50% greater than for 1900-39. A monthly climatic water balance model was developed and calibrated to analyze the impact of changes in air temperature and precipitation regimes on the basin runoff. Particularly emphasized in the study are the conditions causing an increase in water supplies during the present regime, the record low Lake Erie water levels of 1964, and the extreme high levels of 1952 and the early 1970's. Future applications of the model are also discussed. (See also W88-01203) (Author's abstract)
W88-01244

DYNAMIC OPTIMAL LAKE REGULATION FOR QUANTITY AND QUALITY OBJECTIVES,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W88-01246

INFLUENCES OF WEATHER PATTERNS ON WETLAND FLOODINGS,
Louisiana State Univ., Baton Rouge. Dept. of Marine Science.
For primary bibliographic entry see Field 2L.
W88-01263

EFFECTS OF WEATHER MODIFICATION ON WATER SUPPLY FROM RESERVOIRS IN UTAH,
Law Engineering Testing Co., Englewood, CO.
For primary bibliographic entry see Field 3B.
W88-01267

ACID PRECIPITATION AND BUFFER CAPACITY OF LAKES IN THE SIERRA NEVADA, CALIFORNIA,
California Univ., Santa Barbara. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5B.
W88-01277

IMPACT OF ATMOSPHERIC DEPOSITION ON THE WATER QUALITY OF EVERGLADES NATIONAL PARK,
Everglades National Park, Homestead, FL.
For primary bibliographic entry see Field 5C.
W88-01279

POTENTIAL FOR ACID PRECIPITATION DAMAGE TO LAKES OF THE SIERRA NEVADA, CALIFORNIA,
California Univ., Berkeley. Lawrence Berkeley Lab.
For primary bibliographic entry see Field 5C.
W88-01282

VARIATION IN ECOSYSTEM SENSITIVITY AND RESPONSE TO ANTHROPOGENIC ATMOSPHERIC INPUTS, UPPER GREAT LAKES REGION,
Michigan Technological Univ., Houghton. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W88-01283

PROCEEDINGS: CE WORKSHOP ON RESERVOIR RELEASES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 5G.
W88-01319

POLICY ISSUES ASSOCIATED WITH RESERVOIR RELEASES,
Tennessee Valley Authority, Knoxville.
For primary bibliographic entry see Field 6E.
W88-01320

TVA RESERVOIR RELEASE IMPROVEMENTS: AN OVERVIEW,
Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.
For primary bibliographic entry see Field 5G.
W88-01321

WESTEX REVISITED: PREDICTED VERSUS OBSERVED RESERVOIR TURBIDITY,
Army Engineer District, Portland, OR.
For primary bibliographic entry see Field 5G.
W88-01323

EFFECTS OF AERATION AND MINIMUM FLOW ON THE BIOTA AND FISHERY OF NORRIS TAILWATER,
Tennessee Valley Authority, Knoxville.
For primary bibliographic entry see Field 5G.
W88-01325

LAKE GREESON AND LITTLE MISSOURI RIVER MODELING STUDIES,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5G.
W88-01327

HOWARD A. HANSON RESERVOIR, WASHINGTON, TEMPERATURE ANALYSIS MATHEMATICAL MODEL INVESTIGATION,
For primary bibliographic entry see Field 5G.
W88-01328

SELECTIVE WITHDRAWAL STRUCTURE OPERATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5G.
W88-01332

APPLICATION ON THE SELCIDE MODEL IN THE NASHVILLE DISTRICT,
Army Engineer District, Nashville, TN.
For primary bibliographic entry see Field 5G.
W88-01333

SYSTEM SPILL ALLOCATION FOR THE CONTROL OF DISSOLVED GAS SATURATION ON THE COLUMBIA RIVER,
Army Engineer Div. North Pacific, Portland, OR.
For primary bibliographic entry see Field 5G.
W88-01334

SIMULTANEOUS MULTIPLE-LEVEL WITHDRAWAL THROUGH SINGLE WET WELL STRUCTURES FOR DOWNSTREAM WATER QUALITY MAINTENANCE,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5G.
W88-01335

SINGLE WET WELL BLENDING AT APPLEGATE LAKE, OREGON,
Army Engineer District, Portland, OR.
For primary bibliographic entry see Field 5G.
W88-01336

OXYGENATION OF RELEASES FROM RICHARD B. RUSSELL DAM,
Army Engineer District, Savannah, GA.
For primary bibliographic entry see Field 5G.
W88-01338

IN-RESERVOIR AERATION SYSTEMS,
Tennessee Valley Authority, Chattanooga.
For primary bibliographic entry see Field 5G.
W88-01339

EPILIMNETIC PUMPS TO IMPROVE RESERVOIR RELEASES,
Tennessee Valley Authority, Norris. Engineering Lab.
For primary bibliographic entry see Field 5G.
W88-01340

LOCAL DESTRATIFICATION SYSTEM FOR MARK TWAIN LAKE,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5G.
W88-01341

LAKE ALLATOONA - AN EARLY EXPERIENCE IN DESTRATIFICATION REVISITED,
Corps of Engineers, Mobile, AL. Mobile District.
For primary bibliographic entry see Field 5G.
W88-01342

PNEUMATIC DIFFUSERS,
Bureau of Reclamation, Denver, CO.
For primary bibliographic entry see Field 5G.
W88-01343

FISH, PATHOGENS AND ENVIRONMENT IN EUROPEAN POLYCULTURE.
For primary bibliographic entry see Field 5C.
W88-01494

TRANSAMINASE ENZYME ACTIVITY OF CYPRINID FISH DEPENDING ON ENVIRONMENTAL FACTORS AND BACTERIAL INFECTION,
Fisheries Research Inst., Szarvas (Hungary).
For primary bibliographic entry see Field 5C.
W88-01496

HISTOPATHOLOGICAL DIFFERENTIAL DIAGNOSIS OF GILL CHANGES WITH SPECIAL REGARD TO GILL NECROSIS,
Orszagos Allategeszsegugyi Intezet, Budapest (Hungary).
E. Kovacs-Gayer.
IN: Fish, Pathogens and Environment in European Polyculture. Symposia Biologica Hungarica, Vol. 23. Akademiai Kiado, Budapest, Hungary. 1984. p 219-229, 10 fig, 17 ref.

Descriptors: *Fish pathology, *Gills, *Toxicity, *Ammonia, *Water pollution effects, Pesticides, Heavy metals, Histology, Fish parasites, Fish diseases, Toxicity, Bacteria, Fish toxins, Ecological effects, Environmental effects, Morbidity.

The results of histological examinations in 1979 and 1980 on gill necrosis are summarized. In the pathogenesis of gill necrosis, acute and chronic inflammatory stages were established that may develop into diffuse necrosis. By histological exami-

nation, data were gained for differential diagnosis of gill necrosis of carp. It was stated that histopathology is important in the diagnosis of the disease, especially at early stages. but the fact must also be considered that anoxia, ammonia toxicosis and the effect of pesticides, and heavy metal ions can also be the cause of acute inflammation in the gill. Pathology of the disease is often aggravated by parasites and bacteria such as Flexibacter spp. (See also W88-01494) (Author's abstract)
W88-01498

2J. Erosion and Sedimentation

PATTERNS OF SEDIMENTATION AT DEGRAY LAKE, ARKANSAS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
W. F. James, and R. H. Kennedy.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 461-501, 18 fig, 3 tab, 22 ref.

Descriptors: *Limnology, *Sedimentation, *DeGray Lake, *Arkansas, *Reservoirs, Seasonal variation, Vertical distribution, Longitudinal distribution, Deposition, Stratification, Carbon radioisotopes, Thermocline, Algae, Sediment load, Lake sediments.

Seasonal, longitudinal, and vertical patterns in deposition, measured with sedimentation traps, were identified at DeGray Lake, a large U.S. Army Corps of Engineers impoundment. During winter and spring, high river loads associated with storm events caused pronounced longitudinal gradients in water quality and deposition. The headwater region acted as a nutrient sink during these periods, experiencing the greatest deposition rates. During the summer stratified months, river nutrient loads were minimal and material deposition decreased substantially. Marked longitudinal gradients in C-14 productivity in summer were apparently related to the release of nutrients stored in headwater sediments during spring. Deepening of the thermocline and the occurrence of algal blooms led to deposition increases in the headwater region in late summer. In general, the deposition of material loads in the headwater region effectively reduced particulate loading to down-reservoir locations. The storage of these materials in the headwater sediments had implications for detrital dynamics and nutrient cycles along the lake's longitudinal axis. (See also W88-01056) (Author's abstract)
W88-01075

GROSS EROSION RATES, SEDIMENT YIELDS, AND NUTRIENT YIELDS FOR LAKE ERIE TRIBUTARIES: IMPLICATIONS FOR TARGETING,
Heidelberg Coll., Tiffin, OH. Water Quality Lab.
For primary bibliographic entry see Field 5B.
W88-01129

PROBLEMS AND PROGRESS IN URBAN SOIL EROSION AND SEDIMENTATION CONTROL: A BICOUNTY PERSPECTIVE,
Lake County Dept. of Planning, Zoning and Environmental Quality, Waukegan, IL.
For primary bibliographic entry see Field 6E.
W88-01140

ILLINOIS AGRICULTURAL SOIL EROSION CONTROL STANDARDS: A USEFUL TOOL FOR NONPOINT SOURCE POLLUTION CONTROL,
Association of Illinois Soil and Water Conservation Districts, Springfield.
For primary bibliographic entry see Field 5G.
W88-01173

AGRICULTURAL NONPOINT SOURCE POLLUTION IN THE MIDWEST,
Illinois Univ., Urbana. Coll. of Agriculture.
For primary bibliographic entry see Field 5B.
W88-01181

CONSERVATION SERVICE FIELD OFFICE PROGRAM DELIVERY BY HYDROLOGIC AREAS,
Soil Conservation Service, Champaign, IL.
For primary bibliographic entry see Field 3F.
W88-01184

CHANNEL DEVELOPMENT IN THE LOWER REACH OF THE RED RIVER,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W88-01187

WESTEX REVISITED: PREDICTED VERSUS OBSERVED RESERVOIR TURBIDITY,
Army Engineer District, Portland, OR.
For primary bibliographic entry see Field 5G.
W88-01323

2K. Chemical Processes

ENVIRONMENTAL TRANSPORT,
Midwest Research Inst., Kansas City, MO.
For primary bibliographic entry see Field 5B.
W88-01200

GAS PHASE AND PRECIPITATION ACIDITIES IN THE COLORADO MOUNTAINS,
Colorado Coll., Colorado Springs.
For primary bibliographic entry see Field 5B.
W88-01274

SPATIAL AND TEMPORAL TRENDS IN THE CHEMISTRY OF ATMOSPHERIC DEPOSITION IN NEW ENGLAND,
Maine Univ. at Orono. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5B.
W88-01275

RAPID FLUCTUATIONS IN STREAMFLOW PH AND ASSOCIATED WATER QUALITY PARAMETERS DURING A STORMFLOW EVENT,
Northeastern Forest Experiment Station, University Park, PA.
For primary bibliographic entry see Field 5B.
W88-01276

KINETICS MODEL AND SIMULATION OF CONCENTRATION VARIATIONS OF SPECIES OF POLYCHLORINATED BIPHENYLS INVOLVED IN PHOTOCHEMICAL TRANSFORMATION,
Tennessee Univ., Knoxville. Dept. of Engineering Science and Mechanics.
For primary bibliographic entry see Field 5B.
W88-01310

2L. Estuaries

URBAN RUNOFF POLLUTANT INPUTS TO NARRAGANSETT BAY: COMPARISON TO POINT SOURCES,
Rhode Island Dept. of Environmental Management, Providence. Narragansett Bay Project.
For primary bibliographic entry see Field 5B.
W88-01112

INFLUENCE OF NPS POLLUTION IN FLORIDA ESTUARIES: A CASE STUDY,
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 5B.
W88-01114

NONPOINT SOURCE POLLUTION CONTROL IN SMALL BAYS OF PUGET SOUND,
Washington Dept. of Ecology, Olympia, WA. Shorelands Div.
For primary bibliographic entry see Field 5G.
W88-01115

SISTER CHROMATID EXCHANGE IN MARINE POLYCHAETES EXPOSED TO BLACK ROCK HARBOR SEDIMENT,
Environmental Research Lab., Narragansett, RI.
For primary bibliographic entry see Field 5C.
W88-01195

ENVIRONMENTAL CHANGES IN THE BLACK SEA ESTUARINE REGIONS,
Connecticut Univ., Groton. Marine Sciences Inst.
D. Tolmazin.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 283-286, 1 fig, 2 tab, 14 ref.

Descriptors: *Hydrometeorology, *Environmental effects, *Black Sea, *Environmental impact, *Reservoir operation, *Estuaries, Water storage, Reservoirs, Fisheries, Irrigation, Water exchange, Hypoxia, Benthic fauna.

Retention of river water in huge storage lakes built on the rivers entering the Black Sea has severely affected the hydrology and chemistry of the estuarine regions (the Northwestern Black Sea and Azov Sea) and have caused a substantial decline in fisheries. The introduction of large scale irrigation programs has contributed to further deterioration of ecological conditions (hypoxia and mass mortality of benthic forms). Several proposed rehabilitation schemes included use of special structures to reduce water exchange between the estuaries from the sea by dams, and interbasin water transfer from the lower reaches of the Danube River. However, the Soviet leadership has not yet committed itself to any remedial measures. (See also W88-01203) (Author's abstract)
W88-01247

INFLUENCES OF WEATHER PATTERNS ON WETLAND FLOODINGS,
Louisiana State Univ., Baton Rouge. Dept. of Marine Science.
F. C. Wang, and P. D. Scarlatos.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 373-379, 5 fig, 1 tab, 11 ref.

Descriptors: *Hydrometeorology, *Weather patterns, *Wetlands, *Floods, *Louisiana, *Atchafalaya River, Gulf of Mexico, Levees, Coastal marshes, Winds, Precipitation, Marshes, Bayous, Swamps.

The coastal wetland of Louisiana is a depressional watershed characterized by large areas of swamps and marshes and slow natural drainage through bayous and channels. Elevations are low, generally ranging from a maximum of about 30 ft on natural levee terrain to sea level shoreward into coastal marshes. The climatic data of coastal Louisiana have been analyzed and grouped into eight weather types. The synoptic classes are related directly to variations in selected environmental parameters, thereby providing a framework for assessing climate's contribution to the functioning of a natural system. Western Terrebonne Parish, Louisiana, an extensive marsh floodplain, is located at the east of Atchafalaya Bay. A levee was constructed to limit flooding in the area east of the floodway. The area is subject not only to backwater flooding from the Lower Atchafalaya River, but also to tidal flooding from the Gulf and headwater flooding from local rainfall. The relationships between weather patterns and wetland floodings were examined as related to water levels, velocities, and stage characteristics of floodplain. The following conclusions are drawn: (1) Southerly winds, higher river discharges, and high tidal ranges cause a rise in the water stages of marshes and swamps; (2) Under the same climatic conditions, the water stages are higher in the swamps than in the marshes; (3) The greater oscillatory behavior of the marshes shows that tides influence marshes more than swamps; (4) Bayous adjacent to the bay have predominantly

tidally induced currents, while bayous further inland are less affected by tides; (5) Flooding is more predominant in inland bayous and their adjacent wetland than over areas close to the bay; and (6) Winds seem to have less effect on the bayou currents than on the marsh and swamp water stages. (See also W88-01203) (Lantz-PTT)
W88-01263

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

REVERSE OSMOSIS TREATMENT OF DRINKING WATER,
Tennessee Technological Univ., Cookeville.
For primary bibliographic entry see Field 5F.
W88-01493

3B. Water Yield Improvement

EXPERIMENTAL WATER SUPPLY FORECASTS BASED ON SEASONAL PRECIPITATION FORECASTS,
California State Dept. of Water Resources, Sacramento.
R. H. Zettlemoyer.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 235-239, 5 fig, 3 ref.

Descriptors: *Hydrometeorology, *Water supply, *Forecasting, *Water yield, *Precipitation, *Seasonal variation, *California, Runoff, Data evaluation.

In California, a water supply forecast made early in the water year will, by necessity, have a broad probability range associated with the forecast. This wide range is a result of the uncertainty of future precipitation at the time of the forecast. Operational water supply forecasts have always utilized historic precipitation data as input to estimate the possible range of future runoff. With the advent of seasonal precipitation forecasts, there could be an opportunity to reduce the uncertainty of future runoff by incorporating demonstrated seasonal skills into a water supply forecasting procedure. The California Department of Water Resources has been cooperating with the Scripps Institution of Oceanography for several years in an effort to evaluate a seasonal precipitation forecasts. Utilizing data provided by Scripps, techniques were developed to prepare water supply forecasts based on the winter outlook available each December 1. Hindcasts have been made for the last five winters and results show that reductions in probability ranges may be possible. (See also W88-01203) (Author's abstract)
W88-01240

EVALUATION OF OPERATIONAL CLOUD SEEDING PROJECTS,
Illinois State Water Survey Div., Champaign. Meteorology Section.
C. F. Hsu, and S. A. Changnon.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 383-387, 3 fig, 20 ref. NSF Grant Nos. ATM 79-05007 and ATM 81-07027.

Descriptors: *Hydrometeorology, *Water yield forecasting, *Cloud seeding, *Weather modification, *Simulation analysis, Evaluations, Precipitation, Rainfall.

There is a growing demand to 'properly' perform statistical-physical evaluations of operational weather modification projects. Controversies generated by reanalyses of the past operational projects have been increasing. Useful evaluations can be accomplished with 'careful' target-control analyses (temporal and spatial). Extensive simulation studies have been performed to investigate the statistical powers of a collection of evaluation techniques for various modification scenarios, and high power technique for each scenario has been identified. A few past operational projects also have been evaluated to test the more powerful techniques found in the simulation studies. Key issues affecting statistical evaluations have been identified and innovative methods to obtain scientific information (from operational projects) concerning the seeding effects also have been investigated. (See also W88-01203) (Author's abstract)
W88-01264

FEDERAL/STATE COOPERATIVE WEATHER MODIFICATION PROGRAM,
National Oceanic and Atmospheric Administration, Boulder, CO. Weather Modification Program Office.
M. C. Williams.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 389-392, 7 ref.

Descriptors: *Hydrometeorology, *Weather modification, *Interagency cooperation, *Governmental interrelations, *North Dakota, *Utah, Precipitation, Federal jurisdiction, State jurisdiction, Snowpack, Water supply development.

In 1980 NOAA initiated a federally sponsored program of research in weather modification in cooperation with two state sponsored operation programs. The general purpose of this research was to investigate the means for evaluation of large, continuous operational programs, and responded to both expressed needs by state groups and recommendations of scientific study groups. The operational programs selected were sponsored by the states of North Dakota and Utah and represent modification attempts for summer convective precipitation augmentation, and winter snowpack augmentation. The approach to the program involved extensive design activities utilizing contractually obtained expertise for a broad sector of the field. The design activities were followed by field investigations in 1980 and 1981. Specific goals in the early stages of the program focused on definition of modification potentials and verification of appropriate hypotheses. Preliminary results are available from both of these years. Renewed funding support for activities in the two states provides the basis for continuation in 1982. This program provides an example of cost-effective research achieved by cooperative efforts with on-going operations in a technical area with potential for enhancing water supply. (See also W88-01203) (Author's abstract)
W88-01265

CLIMATOLOGICAL BACKGROUND STUDIES FOR OPERATIONAL WEATHER MODIFICATION,
Oklahoma Climatological Survey, Norman.
A. Eddy.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 393-399, 5 fig, 4 tab, 4 ref. BUREC Contract No. 0-07-81-V0144.

Descriptors: *Hydrometeorology, *Precipitation forecasting, *Water yield forcasting, *Model studies, *Weather modification, *Climatology, *Cloud seeding, *Remote sensing, *Precipitation, Rainfall, Radar, Runoff, Soil water, Data interpretation.

An effective weather modification program requires information concerning the space-time distributions of seeding opportunities in the area of interest. The successful evaluation of such programs also requires information concerning the expected values of rainfall characteristics. The Oklahoma Climatological Survey is producing such information using: (a) Manually Digitized Radar data to infer cloud climatologies as a function of time of day and week of the year; (b) Daily COOP data sets with a space resolution of about 270 sq mi/station to infer surface rainfall, runoff, and soil moisture distribution characteristics, and (c) Rawinsonde data transformed by the Hirsch one-dimensional Great Plains Cloud model to infer the climatology of atmospheric structure. With these climatologies in hand, one can assess the time, place and frequency of occurrence of seeding opportunities under stated physical hypotheses concerning precipitation enhancement (or reduction); furthermore, the time required to obtain a data sample adequate to evaluate the project for given statistical hypotheses can be estimated. The marginal value of additional observation systems can also be estimated. (See also W88-01203) (Author's abstract)
W88-01266

EFFECTS OF WEATHER MODIFICATION ON WATER SUPPLY FROM RESERVOIRS IN UTAH,
Law Engineering Testing Co., Englewood, CO.
D. S. Bowles, and M. Frantz.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 401-408, 1 fig, 4 tab, 4 ref.

Descriptors: *Hydrometeorology, *Water yield forecasting, *Hydrograph analysis, *Drought, *Weather modification, *Reservoirs, *Utah, *Water supply, Water supply development, Cloud seeding, Hydrographs, Reservoir storage, Reservoir evaporation, Cost-benefit analysis.

As part of Southwest Drought Research Program, the effects of a proposed standby cloud seeding program on water supply from reservoirs in Utah were estimated. Reservoir inflows for four systems of reservoirs were estimated using a procedure based on the National Weather Service (NWS) water supply forecasting procedures. Typically, these procedures comprise a multiple regression of seasonal runoff volume on rainfall, snowwater equivalent, and runoff in the previous year. It was necessary to adapt the basic NWS procedure to improve its applicability for predicting reservoir inflows in drought years. Daily hydrographs of reservoir inflow were obtained by backrouting recorded outflow hydrographs through reservoirs using records of reservoir contents and evaporation estimates. At reservoirs where outflows are not recorded, inflow hydrographs were developed using hydrograph transfer techniques. Reservoir inflow volumes and hydrographs were obtained for two standby cloud seeding designs for the drought years of 1934 and 1977. With the help of river commissioners and other knowledgeable individuals, the ownership of increases in water supply from each reservoir was determined according to the water rights system. This information was utilized as the basis for a benefit/cost evaluation of alternative proposed standby cloud seeding designs. Both the procedures for estimating water supply under various cloud seeding designs, and the results in terms of estimates of water supply increases and ownership of these increases are described. (See also W88-01203) (Author's abstract)
W88-01267

ECONOMIC VIABILITY OF WEATHER MODIFICATION WATER PROJECTS,
Bureau of Reclamation, Washington, DC. Atmospheric Resources Management.
L. Moore.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 409-413, 2 fig, 6 ref.

Descriptors: *Hydrometeorology, *Economic aspects, *Weather modification, *Economic evaluations, *Water supply development, *Colorado River, Cost-benefit analysis, Cloud seeding, Costs, Feasibility studies.

Weather modification demonstration and operational development programs can provide economically viable water projects for the 1980's. Despite the recent high interest rates and austere fiscal policy, weather modification programs are becoming more attractive because of their high projected benefit-to-cost ratios and comparatively

small capital costs. While more conventional water projects are receiving increasing scrutiny and criticism on cost recovery, applied cloud seeding projects offer prompt payback periods even if interest is computed at the current prime rate. Demonstration of operational weather modification techniques, as in the Bureau of Reclamation's proposed Colorado River Augmentation Demonstration Program, offers a variety of substantial benefits through enhancing the effectiveness of existing water projects. This program to confirm and demonstrate the capability of cloud seeding to increase the flow of the Colorado River is expected to establish a technology with a benefit-to-cost ratio of 7:1 to 10:1. By producing an annual average of 1.6 million acre-ft (MAF) in the Colorado River Basin and 0.5 MAF in adjacent basins, operational weather modification could generate an additional $30 million in additional hydropower, create $41 million benefits in salinity reduction, and $39 million in new water supplies. An integral part of this as well as any other weather modification demonstration program is a continuing economic feasibility assessment to provide updated projections of program viability. This continuing assessment must keep the program objectives focused on the goal of augmented water supplies while continually evaluating the probable environment for the technology being demonstrated. Essentially this feasibility assessment will be a high-level management tool to refocus or even suspend the program should the projected benefits begin to fade in view of new data. (See also W88-01203) (Author's abstract)
W88-01268

STATE PERSPECTIVE ON WEATHER MODIFICATION ACTIVITIES,
Colorado Dept. of Natural Resources, Denver. Weather Modification Program.
B. C. Welles.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 415-417.

Descriptors: *Hydrometeorology, *Weather modification, *State jurisdiction, *Regulations, *Colorado, Snowpack, Water supply development, Cloud seeding, Social aspects, Economic aspects, Costs.

Regulatory provisions, controversies surrounding the use of weather modification and significant advances obtainable from broad communication, utilizing the experiences of Colorado State government are discussed. The Colorado mountains provide appropriate topography for winter snowpack augmentation. Interest in use of the technology is accelerated by commercial projects funded by recreation and water users and a major demonstration project proposed by the Bureau of Reclamation. Scientific and human dimension questions raised by the public and important to regulatory agencies include quantification of snowpack increases, downwind effects, and long range environmental consequences. Until understanding of the physical cloud processes is more precise from studies now possible with advanced weather-measuring equipment, the social and economic costs of weather modification can be addressed by analyzing the differences in expenses between light and heavier nonaugmented snowstorms. Research and continued development of the technology can be encouraged by combining regulation and discussion of controversial concerns with a wide variety of interest groups. (See also W88-01203) (Author's abstract)
W88-01269

RESULTS OF THE SHAKEDOWN SEASON FOR THE FIRST PRECIPITATION AUGMENTATION EXPERIMENT OF THE SIERRA COOPERATIVE PILOT PROJECT,
Christian Heritage Coll., El Cajon, CA.
L. Vardiman.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 419-422, 3 fig, 2 tab, 5 ref.

Descriptors: *Hydrometeorology, *Precipitation, *Weather modification, *Sierra Cooperative Pilot Project, Water supply development, Cloud seeding, Sierra Nevada Mountains, Snowpack.

The Sierra Cooperative Pilot Project (SCPP) conducted a shakedown of an exploratory precipitation augmentation experiment in the winter of 1981-82. Equipment and procedures were tested for suitability in the experiment. Dry ice was released from an aircraft in post-frontal convection over the central Sierra Nevada. Seeding was conducted over three-hour time blocks along 20-mile legs parallel to the mountain. Seeding effects were observed by aircraft, radar, and precipitation gages. Results of the shakedown season are described in terms of the seeding responses observed, the procedures developed, and the equipment utilized in the experiment. The modified experimental design, to be implemented in the winter of 1982-83, is described with estimates of the expected seeding effects. (See also W88-01203) (Author's abstract)
W88-01270

COUNTER-SEEDING AND HOW TO AVOID IT,
C. J. Todd, and W. E. Howell.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 423-425, 5 ref.

Descriptors: *Hydrometeorology, *Counter-seeding, *Cloud physics, *Cloud seeding, Weather modification, Cloud water, Ice, Water supply development, Snow.

If clouds are overseeded, the intention of increasing the precipitation may be defeated and decreases may result. The hypothesis is put forward that ice-phase overseeding may convert supercooled cloudwater into ice particles that cannot be collected by precipitation embryos. In summer cumulus, overseeding may freeze drizzle drops into ice pellets that bounce away from collisions with embryos. In water clouds, overseeding may wipe out the supercooled water that is necessary for maintaining the high vapor pressure essential for sticky collisions among ice crystals, thus preventing them from growing into snowflakes large enough to fall to the ground. The new generation of airborne cloud-physics instruments is looked to for measurements by which this hypothesis may be tested. (See also W88-01203) (Author's abstract)
W88-01271

3C. Use Of Water Of Impaired Quality

AGRICULTURE EXPANSION PLANNING: INCORPORATING WATER REUSE,
Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.
M. N. Allam, and D. H. Marks.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 309-313, 3 fig, 14 ref.

Descriptors: *Hydrometeorology, *Water yield forecasting, *Water resource planning, *Agriculture, *Water reuse, *Irrigation practices, *Egypt, *Nile River, Saline water, Mathematical studies, Cultivated lands.

A mathematical model has been built to guide decisions required for agricultural expansion planning. Of particular interest is the case when some or all of the irrigation sources available have saline water. These decisions generally are quantities and locations of all resource inputs, mixing ratio between different waters, if mixing is possible, irrigation network design, required enlargement in existing irrigation system, and crop pattern distribution in the new lands. These decisions are based on the maximum net benefit criteria and are carried out in a mathematical optimization framework. A comprehensive study of the use of this model in a large scale planning problem has been done. This case is based upon the proposed agricultural expansion in the Nile Delta and the Sinai in Egypt. The available irrigation sources in these regions are fresh and saline waters from the River Nile, and from the drains of the existing cultivated lands, respectively. Different alternative schemes for irrigating the new lands have been obtained. An economic approach for enabling the decision makers to analyze the different alternatives it presented. (See also W88-01203) (Author's abstract)
W88-01252

3E. Conservation In Industry

CASE HISTORY - MINIMIZATION OF ONCE-THROUGH COOLING WATER USE AND DISCHARGE FROM BATCH FERMENTOR COOLING,
Upjohn Co., Kalamazoo, MI.
H. C. Molise.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 901-906, 2 fig, 1 tab, 4 ref.

Descriptors: *Water reuse, *Case studies, *Cooling water, *Fermentation, *Water conservation, Wastewater treatment, Waste disposal, Pharmaceutical industry, Industrial water, Water supply.

The Upjohn Company Portage Road Plant synthesizes pharmaceutical products by fermentation and chemical processes. The Plant also formulates and packages pharmaceutical products and is the site of the company's corporate headquarters. The Plant water distribution system is supplied by company owned wells. The largest use of water at the Plant is noncontact cooling. Water is used in a series of multiple applications, where feasible, before discharging. A water conservation study was initiated to: (1) reduce the volume of groundwater used; (2) reduce future capital investment in new wells and water storage facilities; and (3) reduce the volume of spent cooling water which must be discharged to local surface waters. Forty to fifty percent of the well water supply is used for fermentor cooling. Thus, a major focus for water conservation was a study of cooling water use in the Plant's 36 largest fermentors which range in volume from 13,200 to 39,600 gallons (50,000 to 150,000 liters). Antibiotics and steroids are produced in batch fermentation reactions which use once-through well water for temperature control. There are five separate types of fermentors which vary in combination of volume and cooling design. Cooling designs can be classified as parallel banks of either: (1) internally mounted helical coils (various coil pipe diameters are used); (2) external half-pipe jackets mounted on the outside wall of the vessel. About a dozen different fermentation products are made in the various fermentors, each of which has a different batch viscosity. The fermentation process uses cooling water for two separate operations. (See also W88-00963) (Lantz-PTI)
W88-01054

3F. Conservation In Agriculture

UTAH AGRICULTURE RESOURCE DEVELOPMENT LOAN PROGRAM,
Utah Dept. of Agriculture, Salt Lake City.
For primary bibliographic entry see Field 6E.
W88-01098

CONSERVATION SERVICE FIELD OFFICE PROGRAM DELIVERY BY HYDROLOGIC AREAS,
Soil Conservation Service, Champaign, IL.
S. F. Black.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 506-507.

Descriptors: *Water conservation, *Soil conservation, *Illinois, *Erosion, Water quality, Economic aspects, Social aspects, Watersheds, Irrigation, Agriculture, Resources management, Drainage, Flooding.

The major resource concerns in Illinois are soil erosion, water quality, farmland protection, land use changes, water supply, flooding, wildlife habitat, and socioeconomics. In addressing most of

these concerns, the hydrologic area must be considered. In addition, the hydrologic area is a major factor in addressing other concerns such as critical soils, mined land, drainage, and irrigation. The Soil Conservation Service in Illinois is implementing a pilot program in 14 counties and field offices to deliver program services by hydrologic areas. This system provides for developing comprehensive resource plans for watershed areas within each county, organization of case files to deliver services by watershed groups, and reporting of all accomplishments by each county hydrologic unit. The system operates within the current county boundaries with coordination of watershed areas across county lines as applicable. Resource planning on hydrologic areas provides the means for identifying and measuring offsite, as well as onsite, benefits of various conservation alternatives. This allows local decisionmakers to consider and balance the public and private, or offsite and onsite, benefits of alternative strategies for addressing their local resource concerns. Resource plans prepared for hydrologic areas will outline the objectives, goals, and actions established by the local people. Various agency programs will then be used, as applicable, to address or implement specific parts of a resource plan. Delivery of service by hydrologic areas will be expanded to all counties in Illinois in the next few years. (See also W88-01083) W88-01184

AGRICULTURAL LAND IMPROVEMENT AND WATER QUALITY IN SOUTH CENTRAL MINNESOTA,
Mankato State Univ., MN. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5G.
W88-01185

AGRICULTURE EXPANSION PLANNING: INCORPORATING WATER REUSE,
Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.
For primary bibliographic entry see Field 3C.
W88-01252

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

FLOATING DEBRIS CONTROL; A LITERATURE REVIEW,
Cold Regions Research and Engineering Lab., Hanover, NH.
R. E. Perham.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report REMR-HY-2, June 1987. Final Report. 63 p, 9 fig, 18 ref, append.

Descriptors: *Floating debris, *Literature review, *Hydraulic structures, Navigation, Cleanup operations, Booms, Pulpwood.

Floating debris can have an extremely harmful effect on certain hydraulic structures such as flood control works and navigation facilities and is consequently an important concern in maintenance and repair activities. Information found in published sources about equipment and methods used to control floating debris is presented. Also included is an appendix on booms, their functions in the water transportation of pulpwood, and results of laboratory tests of various boom designs which was previously published by the Pulp and Paper Research Institute of Canada and which contains much useful information applicable to booms for control of floating debris. (Author's abstract)
W88-01193

IMPORTANCE OF STREAMFLOW FORECASTING TO WATER MANAGEMENT WITH INSTREAM FLOW CONSIDERATIONS,
Fish and Wildlife Service, Fort Collins, CO.
For primary bibliographic entry see Field 2E.
W88-01235

4B. Groundwater Management

INTERDISCIPLINARY APPROACH TO SHALLOW GROUND WATER CONTAMINATION IN NORTH-CENTRAL MONTANA,
Triangle Conservation District, Conrad, MT.
For primary bibliographic entry see Field 5G.
W88-01104

GROUNDWATER HYDRAULICS.
For primary bibliographic entry see Field 2F.
W88-01344

OPTIMUM LOCATION OF A WELL NEAR A STREAM,
Geological Survey, Lakewood, CO. Water Resources Div.
E. P. Weeks, and C. A. Appel.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 4-28, 6 fig, 12 ref, append.

Descriptors: *Surface-groundwater relations, *Conjunctive use, *Well location, *Well hydraulics, *Streams, *Wells, *Groundwater management, *Groundwater movement, Drawdown, Hydraulic design, Hydraulics, Hydraulic loss, Aquifers, Mathematical equations, Semipervious beds.

In addition to finding the optimum location of a production well completed in an aquifer near a stream with a semipervious bed, the steady state drawdown in a well in the center of a circular island rimmed by a thin, relatively low-permeability layer and the flow nets for a well near a straight stream were examined. The analyses indicate that the larger drawdowns for wells near the stream result from the fact that flux through the semipervious bed is relatively large if the well is quite close to the stream, resulting in substantial hydraulic head loss at the semipervious bed-aquifer interface. This hydraulic head loss must be added to the hydraulic head loss associated with moving water through the aquifer to produce the total drawdown at the well. As the distance from the well to the stream increases, the hydraulic head loss in the semipervious bed decreases rapidly, while the additional hydraulic head loss needed to drive the water through the aquifer from the semipervious bed-aquifer interface to the well increases more slowly, resulting in a decreased total drawdown. Beyond the optimum distance, the aquifer hydraulic head loss increases more rapidly with increasing distance from the well than the semipervious bed hydraulic head loss decreases. The steady state drawdown in a production well located near a fully penetrating stream with a semipervious bed has a minimum if the well is located at a distance equal to 0.305 times the retardation factor and that the dimensionless drawdown at that distance depends only on the ratio of the retardation factor to the production well radius. Appropriate mathematical equations and derivations are presented. (See also W88-01344) (Wood-PTT)
W88-01345

UNIFIED APPROACH TO REGIONAL GROUNDWATER MANAGEMENT,
Humboldt State Univ., Arcata, CA.
R. Willis.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 392-407, 2 fig, 7 tab, 19 ref.

Descriptors: *Groundwater management, *Planning models, *Mathematical models, *Model studies, *Data interpretation, *Aquifers, *Groundwater, *Optimum development plans, Confined aquifers, Planning, Management planning, Mathematical equations, Optimization, Taiwan, Water management.

An optimization methodology for regional groundwater management incorporates the response equations for confined and unconfined aquifer systems. The hydraulic response of the aquifer system is, therefore, an integral part of the optimization model. The same response equations as are normally used in a simulation approach can be incorporated directly within the framework of optimization modeling. In contrast to simulation modeling, the optimization approach identifies the optimal planning or operational policies. In conjunction with multiobjective programming techniques, the system trade-offs and the set of noninferior solutions were identified. The methodology was applied to Yun Lin Basin, Taiwan to determine the optimal groundwater extraction pattern. Groundwater extraction rates were determined for two scenarios, reflecting alternative groundwater development strategies. The results demonstrate the utility of optimization modeling in identifying the potential safe yield of regional groundwater systems. (Wood-PTT)
W88-01361

MAN-MADE POLLUTION OF GROUND WATER AND ITS GEOLOGICAL RELATIONS,
Z. Verraszto.
United Nations, Economic Commission for Europe. WATER/SEM.14/R.8, March 10, 1987. 5 p.

Descriptors: *Water quality control, *Groundwater pollution, *Groundwater recharge, *Hungary, *Groundwater management, *Groundwater mining, Irrigation wells, Nonpoint pollution sources, Confined aquifers, Geohydrology, Water pollution sources, Boreholes, Groundwater level, Water pollution control.

Every kind of impact of human society on groundwater resources may pose problems for environmental protection. During urban development, deforestation causes faster runoff which diminishes groundwater recharge. Since most groundwater polluting agents do not have a point-like character, the processes governing their infiltration and accumulation are hardly measurable. In Hungary, the majority of groundwater resources are usable only for irrigation. To exploit the deeper aquifers, incredible monetary investments must be made. According to the water legislation, a water license is required in Hungary for all kinds of activities which may affect surface or sub-surface waters. In applying for a license, proper regard is given to the technical details of the envisaged project, including water-quality protection. The special protective measures that need to be taken are discussed for the following situations: boring of deep wells with the aim of exploiting confined water resources, and establishment of irrigation wells by developing groundwater resources. While the locality of point-like pollution is usually easily identified, or at least detectable, restrictions on the use of potentially polluting materials and chemical investigations need to be more efficient in order to put an end to adverse effects on groundwater supplies. (Geiger-PTT)
W88-01401

MINE WATER.
International Mine Water Association.
Proceedings of the Second International Congress, Granada, Spain, September 1985. 603 p. Edited by R. Fernandez-Rubio.

Descriptors: *Groundwater management, *Mine drainage, *Coal mining, *Water control, *Groundwater movement, *Aquifers, *Mining engineering, Grouting, Materials engineering, Groundwater, Geohydrology, Drainage, Case studies, Wells, Mathematical models, Model studies, Dewatering, Depressurizing, Groundwater level, Water level, Symposium, Conferences, Spain, Hazards, Safety.

An international symposium on mine water was held in 1985 in Spain. Papers include reports of work on the origins of mine water, surface mine dewatering techniques, underground mine dewatering techniques, the role of water in mine excavations, mine hazards related to water, and new

engineering techniques for special cases. Mathematical models applied to the prediction of mine water inflows are also discussed. (See W88-01409 thru W88-01459) (Wood-PTT)
W88-01408

PROPOSALS ON MINE WATER CONTROL SYSTEM FOR KOTREDEZ COAL MINE,
Central Inst. for Mining Development, Budapest (Hungary).
Z. Kesseru, I. Havasy, and I. Bagdy.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 13-26, 6 fig, 17 ref.

Descriptors: *Coal mining, *Mine water management, *Groundwater management, *Water management, *Groundwater, Water control, Kotredez Mine, Yugoslavia, Mine drainage, Karstic water, Sediment transport, Recharge, Water level, Drainage, Sediment control.

Kotredez Mine, located in the Zasavski Miocenic Brown Coal Basin in Yugoslavia, was partially flooded by a karstic water inrush carrying a large number of solid particles. Hungarian Institutions contributed to the operations and measurements, and assisted with the planning and designing of urgent and long-term control measures. The estimation of the key hydrogeological data, the planning of the variables of the control systems, and the design of the drainage and sediment treatment plants were discussed. (See also W88-01408) (Author's abstract)
W88-01410

MINIMIZING WELL LOSSES IN DEWATERING WELLS IN FRACTURED ROCK,
Memorial Univ. of Newfoundland, St. John's. Dept. of Earth Sciences.
L. C. Atkinson, and J. E. Gale.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 69-81, 8 fig, 2 tab, 17 ref.

Descriptors: *Well hydraulics, *Well function, *Groundwater management, *Dewatering wells, Wells, Dewatering, Groundwater, Mathematical models, Data interpretation, Drainage wells, Model studies, Mathematical equations, Mathematical studies, Drawdown, Geohydrology, Mine drainage, Pumping.

In order for mine dewatering operations utilizing wells to be cost-effective, it is important that each well be hydraulically efficient. Well loss is a non-beneficial drawdown which hinders this goal, particularly in wells completed in fractured rock. The traditional method for quantifying well loss has been by means of the step-drawdown test, but this purely empirical approach provides little information on the nature and causes of well loss. Using current concepts of fractured rock hydrology, a more deterministic mathematical model for the response to pumping of a well tapping horizontal fracture is developed. This model can be used to evaluate the potential effects on minimizing well losses of two wellbore stimulation techniques: enlarging the wellbore and hydraulic propping. It was concluded that simply increasing the diameter of the wellbore of any dewatering well experiencing significant well loss might be the most economic method of improving the efficiency of dewatering operations, (See also W88-01408) (Author's abstract)
W88-01415

DEVELOPMENT OF AN OPEN PIT COAL MINE DEWATERING PLAN IN CESAR DEPARTMENT, COLOMBIA, S.A.,
Independent Consultants, Denver, CO.
P. E. Brown, R. G. Smith, and L. Lombardo.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 83-94, 6 fig, 2 ref.

Descriptors: *Dewatering, *Coal mining, *Groundwater movement, *Project planning, *Model studies, *Data interpretation, *Groundwater management, Colombia, South America, Geohydrology, Design flow, Costs, Water control, Mathematical models, Management planning.

To design a mine dewatering plan for a proposed multiseam open pit coal mine in Cesar Department, Columbia, S.A., a four-month hydrogeological investigation was conducted in the Boqueron Syncline Reserve area. The groundwater flow regime in the vicinity was delineated in terms of flow direction and hydraulics, the water inflows were predicted for the proposed mine using finite difference and analytical modeling, and preliminary design and cost estimates were made for groundwater and precipitation runoff control measures. Geohydrologic mapping, piezometer installation, hydraulic testing and water quality testing methods and results were detailed. The conclusions drawn from the investigation permitted appropriate suggestions for the design and cost estimates of an effective dewatering and depressurization system. (See also W88-01408) (Wood-PTT)
W88-01416

ANALYTICAL AND GRAPHICAL TECHNIQUE TO DETERMINE THE SPACING OF DRAINAGE WICKS FOR PRESSUE RELIEF IN AN OPEN PIT COAL MINE,
Atomics International Div., Richland, WA. Energy Systems Group.
R. M. Craig, and L. L. Mink.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 95-103, 2 fig, 7 ref.

Descriptors: *Drain spacing, *Coal mining, *Groundwater management, *Dewatering, *Drainage practices, *Data interpretation, Mathematical equations, Mathematical studies, Drainage, Pressure conduits, Artesian pressures, Aquifers, Depressurization wicks, Case studies, Colombia.

Open-pit mining is sometimes conducted in areas where the artesian pressures contained in aquifers underlying the pit's floor are great enough to cause the floor to heave. In order to reduce this pressure several methods are used, one of which is a pressure relief well or depressurization wick. The wick consists of a borehole which is filled with gravel and cased at the surface. The wick is then allowed to flow freely, thus reducing pressure near its location. The spacing and depth of these wicks can be determined by a simple analytical and graphical technique which considers the weight of material overlying the aquifer and the artesian force within the aquifer. An example of the technique using data from a Colombian coal mine is presented. (See also W88-01408) (Author's abstract)
W88-01417

PROPOSAL OF CRITERIA FOR SELECTION OF DEWATERING METHODS IN SURFACE MINING,
J. Libicki.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 105-112, 3 ref.

Descriptors: *Groundwater management, *Mine drainage, *Water control, *Dewatering, *Groundwater, Groundwater level, Water level, Water management, Mining engineering, Comparison studies, Geohydrology, Costs.

The characteristics, advantages, and disadvantages of the dewatering systems available for lowering the groundwater level preceding mining operations, for preventing groundwater inflow into open pit mines, and for removing collected groundwater and rainwater are reviewed. These systems are: (1) drainage wells; (2) sealing screens; (3) underground galleries; (4) horizontal drains; (5) needled filters; (6) ditches; and (7) pumping stations. Criteria which were discussed for the selection of an appropriate dewatering system included hydrogeological conditions, mine operating conditions, environmental protection requirements, and operational costs. The analysis of possible choices often leads to the selection of a system which combines several of the available methods. (See also W88-01408) (Wood-PTT)
W88-01418

DRAINAGE OF MINING DEVELOPMENT IN A NEOGENE LIGNITE DEPOSIT IN HUNGARY,
Technical Univ. of Heavy Industry, Miskolc (Hungary).
M. Jeney, and R. Jambrik.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 113-123, 6 fig, 5 tab, 6 ref.

Descriptors: *Groundwater management, *Coal mining, *Dewatering, *Groundwater movement, *Water control, Hungary, Lignite, Groundwater reservoirs, Aquifers, Mine drainage, Depressurizing, Geohydrology, Tectonics, Hydraulic profiles, Rock properties, Groundwater.

The neogene Borsod lignite basin which is 620 sq km in area is located in northeastern Hungary, north of Miskolc. The Dubicsany lignite deposit is explored by drilling in its northwestern section. The construction of an inclined shaft began in 1984. The inclined shaft crosses three water-bearing sand seams forming separate closed-table water reservoirs. Possible solutions for the problem of drainage of the inclined shafts are dewatering or depressurizing and dewatering the reservoirs. The geology, tectonics, and hydrogeology of the area, as well as the hydraulic and rock physical parameters of the reservoirs were studied. A double-stage drainage system was suggested. Stage one is performed from the surface preceding the actual shaft sinking. Water level reduction will be carried out by submersible pumps in wells at 2.5 m distance from the future cross-section of the inclined shaft following its advance. It has to reduce water tables remaining after stage one and continuously protect the inclined shaft. The design patterns and data for this system are described. (See also W88-01408) (Lantz-PTT)
W88-01419

HYDROGEOLOGY AND DRAINAGE OF COPPER-COBALT MINES IN THE KOLWEZI AREA OF SHABA, REPUBLIC OF ZAIRE,
Hydro-Geo Consultants, Golden, CO.
V. Straskaba, J. Placet, and M. Holubec.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 125-139, 7 fig, 4 tab, 9 ref.

Descriptors: *Groundwater management, *Copper-cobalt mining, *Mine drainage, *Groundwater movement, *Geohydrology, Model studies, Zaire, Drainage, Dewatering, Monitoring wells, Test wells, Pumping tests, Aquifers, Planning, Groundwater.

Hydrologic conditions have considerable impact on mine planning, development, and operation in the Kolwezi area of Shaba, Republic of Zaire, where open pit and underground copper-cobalt mines are developed. A comprehensive hydrologic study of the Kolwezi area included installation of many test and monitoring wells, performance of aquifer pumping tests and studies of local surface and groundwater hydrology. Results of the hydrologic investigation were analyzed and recommendations for mine dewatering and water handling were presented. The selection of an optimal long term dewatering scheme for open pit mines was based on computer modeling with the use of a three dimensional finite-difference groundwater flow model. (See also W88-01408) (Wood-PTT)
W88-01420

PLANNING AND REALIZATION OF A CONSTANTLY INCREASING PREVENTION SYSTEM AGAINST UNDERGROUND WATER IN MINES,
Borsod Coal Mining Co., Miskolc (Hungary).
B. Balogh, and A. Szepessy.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 141-156, 13 fig, 8 ref.

Descriptors: *Groundwater management, *Coal mining, *Water control, *Dewatering, *Mine drainage, *Groundwater, Hazards, Safety, Groundwater level, Wells, Mathematical equa-

tions, Simulation, Hungary, Tectonics, Case studies.

Water hazard occurs in the majority of the mines in the Borsod brown coal basin in Hungary. Accident prevention is accomplished by lowering the water level using mine wells. A case study of the Feketevolgy mine is presented; the optimum safe height of the water column when resting in sand was defined. During the planning for water level lowering, it was assumed that the fault near the longwall panel of the mine is an impermeable surface; an assumption which proved correct. The estimation was resolved through the use of two different theoretical methods. In practice it was found that the wells enter the water yield not at the same time, but in gradually increasing systems. Water level sinking then takes shape in compliance with this system. Technology of well construction follows the given circumstances, but can be ammended with further planning and experimental work. Computer simulation of water prevention provides new opportunities for correct planning and the development of the optimum prevention system. (See also W88-01408) (Author's abstract)
W88-01421

WATER CONTROL AT THE BAKONY BAUXITE MINES COMPANY,
Bakonyi Bauxitbany Vallalat, Topolca (Hungary).
I. Farkas.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 157-167, 7 fig.

Descriptors: *Groundwater management, *Dewatering, *Data acquisition, *Mine drainage, *Water control, Bauxite mining, Hungary, Hazards, Safety, Geohydrology, Drinking water, Water use, Groundwater level, Tectonics, Water table lowering, Computers, Automation, Data evaluation.

The Bakony Bauxite Mines Company fights the impending hazards of water inrushes in the underground mines at Nyirad by water table lowering. The hydrological conditions which necessitate this expensive method are detailed. The water control system, which has been continuously improved since its implementation in 1966, is described. Since 1975, data collection and controlling techniques for the dewatering system have been computerized to insure precise measurement, continuous control and processing of the operating characteristics. The system used has been a MINDATA II-type data collecting configuration connected to an EMG 666-type computer. MINDATA measures the data of the measuring points every 20 seconds, recording this data on magnetic tape once every hour. Evaluation of the data is then made by the company every two weeks. The timely prediction and prevention of damage caused by drainage is thereby attended to. In addition, a considerable proportion of the drainage water is utilized in the modern drinking water supply system. (See also W88-01408) (Wood-PTT)
W88-01422

INVESTIGATION OF THE HYDROGEOLOGICAL PROBLEMS IN SOME MINES IN INDIA,
Central Ground Water Board, Lucknow (India).
For primary bibliographic entry see Field 2F.
W88-01423

PREVENTATIVE MEASURES AGAINST FLOODING IN TWO UNDERGROUND MINES,
Empresa Nacional de Electricidad S.A., Andorra.
H. A. Gomez.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 241-253, 7 fig, 6 ref.

Descriptors: *Groundwater management, *Coal mining, *Flooding protection, *Mine drainage, Teruel, Lignite, Underground structures, Drainage, Mud, Geohydrology, Geologic formations, Hydrostatic pressure, Geologic fractures, Case studies.

'La Oportuna' and 'Innominada' are two underground black lignite mines situated in the Andorra coalfield (Teruel) that are operating in an Albense deposit. The overlying material is basically formed by soft clays and sands that collapse quickly into the mined cavity, creating problems caused by water and mud floods. In 'La Oportuna' mine the geometry of the exploitation and the hydrostatic pressure are the main factors that control the intensity of the flood risks. In the 'Innominada' mine the intensity of the floods is related to the hydrostatic pressure and other geological factors such as the presence of fractures that weaken the rock and paleochannels that are the main water circulation pathways. The origin of the water, the causes of the flooding, and the preventative measures that were adopted were explained. (See also W88-01408) (Author's abstract)
W88-01429

HYDROGEOLOGICAL ASPECTS OF GROUNDWATER HAZARD IN POLISH UNDERGROUND MINING,
Academy of Mining and Metallurgy, Krakow (Poland). Inst. of Hydrogeology and Engineering Geology.
Z. Wilk.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 269-276, 1 tab.

Descriptors: *Groundwater management, *Mining hazards, *Mine drainage, *Groundwater movement, *Geohydrology, *Groundwater hazards, Hazards, Poland, Mineral industry, Planning, Classification, Mine classification, Water inflow.

The characteristic hydrogeological features of the most important mineral deposits mined in Poland are listed and the classification system used to distinguish underground mines by degree and type of water hazards was detailed. The proper evaluation of a water hazard depends on a thorough exploration of the hydrogeological, geomechanical and mining conditions; the methods employed in Poland are described. Because groundwater hazards are prevalent in underground mines, preventative measures aimed at reducing the hazards of groundwater by preventing or delaying water inflows, or by reducing inflow intensity are employed. Strategies including plans for evacuation of water that infiltrated a mine, for water-tight separation of a flooded area, and for sealing fractures through which water entered were also mentioned. (See also W88-01408) (Wood-PTT)
W88-01431

CONTROL OF WATER IN UNLINED MINE SHAFTS AND TUNNELS,
Carleton Univ., Ottawa (Ontario). Inst. of Civil Engineering.
G. E. Bauer.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 277-285, 7 fig, 4 ref.

Descriptors: *Groundwater management, *Mine drainage, *Groundwater movement, *Mine engineering, *Tunnels, Project planning, Geohydrology, Seepage, Dewatering, Grouting, Freezing, Drainage.

Proper control of groundwater is in many cases the most important factor influencing the success or failure of an underground mining project. Water seeping into an underground opening can impede the mining process by making it difficult for men and machinery to work efficiently, and in many cases, inflowing water can halt operations. Various methods used in the control of groundwater in mining projects from the initial design, to the construction and abandonment of the mine are discussed. Some of the methods need a large inventory of specialized plant and equipment in order to carry out such remedial measures as grouting, freezing, dewatering, and others. Methods of water control in tunnels and shafts are detailed. (See also W88-01408) (Author's abstract)
W88-01432

WATER-BLOCKING ENGINEERING IN THREE HORIZONTAL CONNECTION ROADWAYS BETWEEN FANGEZHUANG MINE AND LUJIATUO MINE, KAILUAN MINING ADMINISTRATION, UNDER FLOWING WATER CONDITION,
Ministry of Coal Industry, Beijing (China).
B.-Q. Chen, and G.-Q. Dai.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 287-306, 4 fig, 6 tab, 1 ref.

Descriptors: *Mine drainage, *Groundwater management, *Drainage, *Flooding, China, Boreholes, Water-blocking method, Flood flow, Flow control, Water control, Case studies.

The successive mine inundations of the Fangezhuang Mine (F. Mine) and Lujiatuo Mine (L. Mine), Kailuan Mining Administration, and the methods of water control for the mining areas of the eastern five mines are described. The three-section water-blocking method involving small diameter boreholes employed in the three horizontal connection roadways between F. Mine and L. Mine is detailed. The water inrush (quantity of flowing water was 388.8 cu m/minute) occurred in L. Mine on June 6th and lasted 185 days until the water-blocking engineering succeeded on December 7th. As a result of the three connection roadways, the water flow was reduced to 1.7 cu m/minute, not including the normal mine water inflow. The water-blocking was 99.6% effective. The threat of water flooding in the adjacent Linxi Mine, the Zhao gezhuang Mine, and the Tangjiazhuang Mine was removed and preparations for mine restoration could be carried out in L. Mine. Observations made in this case study of water-blocking engineering are presented. (See also W88-01408) (Author's abstract)
W88-01433

DEWATERING AND DEPRESSURISATION STUDIES FOR DEVELOPMENT OF THE LOCHIEL OPEN PIT MINE, SOUTH AUSTRALIA,
Coffey and Partners Pty Ltd., Sydney (Australia).
B. C. Burman, and T. D. Sullivan.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 307-324, 10 fig, 2 tab, 5 ref.

Descriptors: *Mine drainage, *Groundwater management, *Water control, *Dewatering, *Depressurization, Drainage, Coal mining, Lignite, South Australia, Multiaquifer system, Aquifers, Artesian head, Groundwater, Pit stability, Depressurization wells, Field tests, Feasibility studies.

The Lochiel Lignite Deposit in South Australia is being evaluated as a possible fuel source for a 1000 MW power station. The deposit lies in a semi-isolated Tertiary basinal sequence which is characterized by unconsolidated overburden containing a multi-aquifer system subject to excess artesian groundwater heads of 20 m. These conditions represent a particularly difficult environment for open cut mine development. Studies showed that gradual depressurization of the fine-grained overburden units, in addition to dewatering of the major aquifers, will be required to maintain dry and efficient working conditions as well as to promote pit stability. Trial depressurization bores were installed, operated and monitored over periods of up to 3 months to provide field confirmation of the feasibility of depressurizing fine-grained overburden units within a realistic timescale. These trial bores, consisting of wells screened in the major basal aquifer and filter packed over their full length to promote depresurization through minor aquifer zones, were pumped at rates up to 35 liters/second and achieved average dissipation of up to 35% within 30 days. These results were used to develop the preliminary design of a combined groundwater control system for the Lochiel Deposit which will dewater the major aquifer zones and sufficiently depressurize the overburden to permit dragline mining under efficient and economical conditions. (See also W88-01408) (Author's abstract)
W88-01434

APPLICATIONS OF FLOWCUT GROUTING CURTAIN IN MINE WATER PREVENTING AND CONTROLLING,
Institute of Geology and Exploration, Xian (China).
S. C. Chi.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 325-339, 4 fig, 4 tab.

Descriptors: *Mine drainage, *Groundwater management, *Flowcut grouting, *Grouting, *Water control, China, Coal mining, Metal mining, Geohydrology, Goundwater, Aquifers, Aquiludes, Drainage.

The method of cutting waterflow with a grouting curtain is used to change geological and hydrogeological conditions in order to control the water in underground coal and metal mines. The method involves pouring a setting gel of water resistant material into the largest water conducting channels in the aquifer in order to change the aquifer into an aquilude. The water conducting channels are then blocked, creating an artificial wall in the aquifer, thereby cutting the water supply to it. By changing the unfavorable hydrogeological conditions, mineral deposits can be drained effectively and economically. Conditions under which flowcut grouting curtains are effective in the control of mine water are described. Several specific situations and the appropriate arrangement of the curtains and choice of grouting material are detailed. (See also W88-01408) (Wood-PTT)
W88-01435

RESEARCH AND APPLICATION OF NEW GROUTING MATERIALS IN CHINA COAL INDUSTRY,
Beijing Research Inst. of Mine Construction (China).
For primary bibliographic entry see Field 8G.
W88-01436

NEW DEVELOPMENTS IN THE FIELD OF GROUTING USING INTEGRATED METHOD,
STG Specialized Association, Antratsit (USSR).
For primary bibliographic entry see Field 8G.
W88-01438

ELIMINATION OF ABANDONED FLOODED WORKINGS DURING SHAFT SINKING AT YUZHNAYA MINE,
For primary bibliographic entry see Field 8G.
W88-01439

RESEARCH OF GROUTING TECHNIC OF CONSOLIDATED SAND AND SEALING WATER BY A NEW CHEMICAL MATERIAL FOR WATER-DRAIN TUNNEL,
Northeast Coll. of Tech., Shenyang (China). Dept. of Mining Engineering.
For primary bibliographic entry see Field 8G.
W88-01440

COMBINED SYSTEM OF SEALING A MINE UNDER HEAVY KARSTIC WATER HAZARD,
Central Inst. for Mining Development, Budapest (Hungary).
L. Szentirmai.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 411-423, 3 fig, 1 tab, 18 ref.

Descriptors: *Grouting, *Materials engineering, *Groundwater management, *Dewatering, *Water control, *Coal mining, Karst, Geologic fractures, Cements, Clays, Grouts, Caves, Sealants, Hungary, Lencseghegy II Mine, Drainage, Mine drainage.

A combined method of limiting mine water to 50 cu m/minute was demonstrated in a new mine, the Lencsehegy II Mine, in Hungary in which karstic water is a severe hazard. The preventative and 'a posteriori' sealing processes used in the combination of water control methods were detailed. Large caves and small fissures were sealed using surface and underground operations involving hydraulic filling materials such as sand and gravel and different grouting slurries including cement slurries, a fly ash-cement slurry, and a clay-cement slurry. The materials were combined in different space and time sequences. Estimation procedures for the amount of sealing material required and selection criteria for the appropriate materials and technologies were presented. (See also W88-01408) (Wood-PTT)
W88-01443

STUDY OF PRETREATMENT GROUTING TECHNOLOGY AT WORKING FACE IN AN AUXILIARY SHAFT OF HUANGHUAI COAL MINE,
Beijing Research Inst. of Mine Construction (China).
For primary bibliographic entry see Field 8G.
W88-01444

SIMULATION OF MASS AND HEAT TRANSFER IN A LARGE KARSTIC RESERVOIR FOR MINE WATER MANAGEMENT,
Central Inst. for Mining Development, Budapest (Hungary).
I. Havasy, and L. Dusza.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 491-501, 4 fig, 9 ref.

Descriptors: *Groundwater movement, *Karst, *Thermal water, *Mine drainage, *Karstic reservoirs, *Simulation analysis, *Mathematical models, Data interpretation, Heat transfer, Mass transfer, Mathematical studies, Hungary, Hydraulic properties, Thermal springs.

The regional simulation of the Transdanubian Mountains, Hungary, using a CCC-type numerical model developed by the Lawrence Berkeley Laboratory, California, U.S.A., is presented. The single-layer, three-dimensional model covers an area of 11,000 sq km with about 600 cu m/minute mass transport. The homogeneous, isotropic elements are specified with hydraulic and heat parameters in accordance with the natural hydrogeological and stratigraphical conditions. The connection between mine water outputs and thermal springs are studied by the simulation of mass and heat transport. The phenomena of porous and karstified rocks were compared in order to make practical conclusions. A detailed mine water management model will be based on this simulation. During the model the main geothermal features of the Transdanubian karstic reservoir appeared. These include: (1) The heat processes of the fissured-karstified rocks are determined by the static heat content; (2) In spite of the hydraulic instability caused by an artificial water discharge there is no remarkable change in the large scale heat balance of the reservoir; (3) Some concentrated water output of high quantity may influence the heat conditions of thermal spring areas locally; (4) The difference between the calculated and adapted specific storage may point out the importance of the rubble rocks connected with the reservoir hydraulically; and (5) Comparing the results of simulations of the porous reservoirs with karstified ones, two types of reservoirs can be recognized with regard to the heat phenomena.(See also W88-01408)
W88-01450

ESTIMATING WATER OUTFLOW RATE OF THE BEDROCK SECTION IN MINE SHAFTS USING HYDROGEOLOGICAL ANALYSIS METHOD,
Ministry of Coal Industry, Beijing (China).
For primary bibliographic entry see Field 2F.
W88-01454

NUMERICAL CALCULATION OF GROUNDWATER INFLOW TO LONGWALL COAL FACES,
Nottingham Univ. (England). Dept. of Community Health.
For primary bibliographic entry see Field 2F.
W88-01455

APPLICABILITY OF CURRENT GROUNDWATER THEORIES FOR THE PREDICTION OF WATER INFLOWS TO SURFACE MINING EXCAVATIONS,
Nottingham Univ. (England). Dept. of Mining Engineering.
For primary bibliographic entry see Field 2F.
W88-01456

SIMULATION OF MINE DRAINAGE OF OIL-SHALE DEPOSITS, PICEANCE BASIN, COLORADO, U.S.A.,
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2F.
W88-01457

APPLICATION OF COMPUTER MODELING FOR THE DESIGN OF OPEN PIT MINE DEWATERING,
Hydro-Geo Consultants, Golden, CO.
V. Straskraba, J. Placet, and M. Holubec.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 579-597, 7 fig, 6 tab, 9 ref.

Descriptors: *Groundwater management, *Computer models, *Dewatering, *Model studies, *Groundwater movement, *Zaire, *Mine drainage, Data interpretation, Copper mines, Cobalt mines, Pumping, Groundwater, Simulation, Finite difference methods.

The copper-cobalt mines in the Kolwezi area of Shaba, Republic of Zaire have complex geologic and geohydrologic conditions. The presence of water bearing strata within the ore-body and in the overburden complicates the open pit mining operation. Pumping of large volumes of groundwater from dewatering wells installed within and on the perimeter of the open pits and from pit sumps is necessary at an early stage of mining. Mine dewatering is an important part of mine planning. Computer modeling with the use of a three-dimensional finite-difference groundwater flow model was used to simulate dewatering schemes for three open pit mines in an area called Dikuluwe-Mashamba. A description of the computer model, calibration procedures used, and the results of simulation of dewatering in several schemes are included. (See also W88-01408) (Author's abstract)
W88-01458

METHOD FOR WATER RESOURCES EVALUATION FOR PREDICTION OF MINE WATER INFLOWS AND FOR COMPREHENSIVE UTILIZATION OF MINE WATER,
Academia Sinica, Beijing (China). Inst. of Geology.
For primary bibliographic entry see Field 2F.
W88-01459

4C. Effects On Water Of Man's Non-Water Activities

EFFECTS OF INTENSIVE AGRICULTURAL LAND USE ON REGIONAL WATER QUALITY IN NORTHWESTERN OHIO,
Heidelberg Coll., Tiffin, OH. Water Quality Lab.
D. B. Baker, K. A. Krieger, R. P. Richards, and J. W. Kramer.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 201-207, 5 fig, 8 tab, 21 ref.

Descriptors: *Agriculture, *Land use, *Ohio, *Water quality, *Nonpoint pollution sources, *Runoff, Crops, Agricultural runoff, Pesticides, Nutrients, Lake Erie, Path of pollutants.

Cropland comprises 80% of the land surface in northwestern Ohio. Runoff of sediment, nutrients, and pesticides from this cropland adversely affects water quality in area rivers, in associated estuaries and bays, and in Lake Erie. Although the terrain is relatively flat, the combination of fine textured

soils, extensive tile drainage, and cropping practices results in unusually large amounts of agricultural pollution. Ten years of detailed studies on streams and rivers of this area reveal several basic characteristics of nonpoint pollution transport. Peak concentrations of particulate and soluble pollutants occur during different parts of the storm hydrograph. Storm to storm and year to year variability is very large. Effects of season and watershed size are also evident. An awareness of these characteristics may be useful in evaluating less detailed studies. (See also W88-01083) (Author's abstract)
W88-01120

CONTROLLING WATER POLLUTION FROM NONPOINT SOURCE LIVESTOCK OPERATIONS,
Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5G.
W88-01121

AGRICULTURAL ISSUES: THE NEBRASKA PERSPECTIVE,
Nebraska Univ.-Lincoln.
For primary bibliographic entry see Field 5G.
W88-01133

ACCUMULATION OF SEDIMENT, NUTRIENTS, AND CESIUM-137 IN PRAIRIE POTHOLES IN CULTIVATED AND NONCULTIVATED WATERSHEDS,
Fish and Wildlife Service, Yankton, SD.
D. B. Martin.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 274-275, 4 ref.

Descriptors: *Sediments, *Water pollution sources, *Nutrients, *Nonpoint pollution sources, *Agriculture, *Environmental effects, *Potholes, Cesium radioisotopes, Farming, Water resources management, Wetlands, Wildlife, Ecological effects, Sedimentation.

Prairie potholes are water-holding depressions of glacial origin that occur throughout 780,000 sq km of prairie in the northcentral United States and southcentral Canada. Collectively, these potholes provide the most productive wetland habitat for waterfowl in North America. Although it constitutes only 10% of the continental waterfowl breeding habitat, this pothole region produces about 50% of the duck crop in an average year, and much more in bumper years. Sediment is currently recognized as an important problem affecting prairie pothole wetlands. Resource managers perceive the impacts of sediment on wetlands as being twofold. First, sediment can reduce and eventually eliminate wetland habitat by filling the pothole basin. Second, sediment may serve as an agent for the transfer of chemical contaminants from the watershed to the wetland. The purpose of this work on sedimentation in pothole wetlands is to determine the relationship between specific agricultural land use practices and sediment deposition, composition, and contaminant impacts. This will better enable resource managers to identify areas of problem deposition (and the cause), to understand biological effects of accelerated sediment yield, and to evaluate feasibility and effectiveness of various mitigative measures to reduce sedimentation. (See also W88-01083) (Lantz-PTT)
W88-01134

BELLEVUE EXPERIENCES WITH URBAN RUNOFF QUALITY CONTROL STRATEGIES,
Bellevue Storm and Surface Water Utility, WA.
For primary bibliographic entry see Field 5G.
W88-01136

EFFECTS OF CARBONATE GEOLOGY ON URBAN RUNOFF,
Tennessee Valley Authority, Norris.
R. P. Betson, and J. D. Milligan.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 281-284, 2 fig, 4 tab, 8 ref.

Descriptors: *Carbonates, *Geohydrology, *Urban runoff, *Environmental effects, *Nonpoint pollution sources, *Karst, Pollutant loads, Groundwater quality, Water quality, Urban hydrology, Hydrologic studies.

Nonpoint source pollution is a function of runoff. In areas underlain by soluble carbonate rock (Karst) much of the potential streamflow drains into the solution cavity drainage system. When Karst areas are urbanized, the increase in storm runoff can be dramatic as compared with preurban conditions. Nevertheless, the runoff yield and consequently the nonpoint source pollution loadings may be less than from areas underlain by less soluble rocks. However, the potential for contaminating groundwater is increased and the ground/surface water quality relationships can become very complex. The hydrology of six watersheds located in Knoxville, Tennessee, which were studied as part of the EPA NURP program are described in terms of their rainfall-runoff relationships and the implications to groundwater recharge and quality. These data along with data from an earlier study illustrate the effect of karst urban hydrology. (See also W88-01083) (Author's abstract)
W88-01137

URBAN STORMWATER QUALITY MANAGEMENT: THE FLORIDA EXPERIENCE,
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 5G.
W88-01139

PHOSPHATE AND PEAT MINING IN FLORIDA,
Saint Johns River Water Management District, Palatka, FL.
C. J. Fall.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 342-343, 10 ref.

Descriptors: *Phosphates, *Peat, *Mine wastes, *Environmental effects, *Florida, *Fate of pollutants, Groundwater quality, Water quality.

Florida is first in the nation in production of nonmetallic minerals and sixth in production of all minerals. Nearly 75% of the phosphate produced in the United States is mined in Florida. Nationally, Florida ranks second in peat production. The major impacts of this phosphate and peat mining are altered surface and groundwater hydrology and loss of habitat, particularly valuable and irreplaceable wetlands. Nonpoint source pollution problems result primarily from land disturbance during mining operations. Surface and groundwater quality are affected by phosphate-processing plants. Some environmental impacts can be mitigated by applying best management practices and reclamation techniques. (See also W88-01083) (Lantz-PTT)
W88-01147

GREAT LAKES POLLUTION FROM LAND USE ACTIVITIES,
Soil Conservation Society of America, Ankenny, IA.
N. Berg.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 487-494, 1 tab, append.

Descriptors: *Nonpoint pollution sources, *Great Lakes, *Land use, *Water quality, *Water pollution sources, Data interpretation, Water quality management, Education, Economic aspects, Regulations.

In 1972, the Pollution From Land Use Activities Reference Group (PLUARG) of the International Joint Commission (IJC) was established. The purpose was to determine the levels and causes of any pollution of the Great Lakes System from land use activities. The group was also asked to recommend appropriate remedial actions to the Governments of Canada and the United States. An early effort of PLUARG was to determine the state-of-the-art. A detailed study plan emphasized four main tasks: (1) Task A: to assess problems, management of programs, and research, and to attempt to set priorities in relation to the best information available on the effects of land use activities on water quality in the boundary waters; (2) Task B: inventory of land use and land use practices, with emphasis on certain trends and projects to 1980 and, if possible, to 2020; (3) Task C: intensive studies of several small watersheds, selected and conducted to permit some extrapolation of data to the entire Great Lakes Basin, and to relate contamination to water quality at river mouths of the System to specific land uses and practices; and (4) Task D: diagnosis of degree of impairment of water quality in the Great Lakes, including assessment of concentrations of contaminants of concern in sediment, fish, and other aquatic resources. PLUARG recommended management plans with four major components: (1) information, education, and technical assistance; (2) planning; (3) fiscal arrangements; and (4) regulation. (See also W88-01083) (Lantz-PTT)
W88-01179

EFFECTS OF CARBONATE GEOLOGY ON URBAN RUNOFF: WATER QUALITY ASPECTS,
Tennessee Valley Authority, Chattanooga.
For primary bibliographic entry see Field 5B.
W88-01182

DURATION OF STREAM TEMPERATURE INCREASES FOLLOWING FOREST CUTTING IN THE SOUTHERN APPALACHIAN MOUNTAINS,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
L. W. Swift.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 273-275, 1 fig, 12 ref.

Descriptors: *Hydrometeorology, *Water temperature, *Streams, *Environmental impact, *Forestry, *Environmental effects, *Clearcutting, *Appalachian Mountains, Logging, Trout, Ecological effects, Thermal pollution.

Cutting timber along small streams in the southern Appalachian Mountains increases water temperature. Although the effect is assumed to be short-lived because of rapid regrowth of dense vegetation, timber harvest in streamside shade zones on National Forest land is carefully regulated to minimize temperature changes and maintain trout habitat. Clearcutting all vegetation over 2.5 cm DBH from a 59.6-ha south-facing watershed in western North Carolina allowed both the magnitude and duration of water temperature increases to be studied. About 958 sq m of stream were exposed. Daily maximum temperatures at the downstream margin of the cutting were increased an average of 3.3 C the first two summers after cutting. The increases declined in the next three summers to 1.2 C. Daily minimums were increased about 1.3 C both winter and summer, but only in the first year. The daily range of water temperatures (maximum minus minimum) was increased during all five summers. A method for predicting water temperature changes was tested and found to overestimate the summer increases. (See also W88-01203) (Author's abstract)
W88-01245

WATER BALANCE MODEL OF THE TRANSDANUBIAN MOUNTAIN RANGE IN HUNGARY FOR MINING PURPOSES,
Hungarian Aluminium Corp., Budapest.
For primary bibliographic entry see Field 2F.
W88-01445

GAME THEORETICAL MODEL FOR THE EXAMINATION OF THE MUTUAL EFFECT OF MINING AND ENVIRONMENTAL CONTROL,
Central Inst. for Mining Development, Budapest (Hungary).
For primary bibliographic entry see Field 6D.
W88-01453

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

ENVIRONMENTAL FEASIBILITY OF USING CREOSOTE CONTAMINATED SOIL AND SLUDGES IN ROADWAY PAVING STRUCTURES,
Alabama Univ., University. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W88-01000

RAPID INDUSTRIAL WASTE SCREENING METHOD,
Chattanooga, TN.
G. E. Kurz, N. Leslie, and R. J. Henderson.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 395-406, 5 fig, 6 tab, 9 ref.

Descriptors: *Wastewater pretreatment, *Pollutant identification, *Wastewater treatment, *Classification, *Chemical analysis, *Microtox, Industrial wastes, Pretreatment of wastewater, Lethal limit, Bioassay, Monitoring, Toxicity.

The City of Chattanooga has operated a comprehensive industrial waste pretreatment program for 6 years and is one of 23 major municipal agencies in the U.S. which has had its program accredited by the US EPA. Screening of many industrial wastes by this costly approach is wasteful because only a few toxic substances may be significant in a specific waste stream. Recently, the Microtox toxicity analyzer system which utilizes a photo-luminescent marine microorganism has become available for researchers. The organism's light output decreases as a function of toxic shock, and this parameter is comparable to the parameters measured by other bioassay techniques. The City's technical staff has found that this system can be used to rank all the local industrial dischargers in order of relative toxicity, and in order of relative toxic impact on the City's wastewater treatment plant. This information enables the pretreatment program manager to allocate scarce resources for monitoring and analysis more effectively. A single inexpensive test may be completed in 15 minutes compared to the more prevalent LC50 fish test which takes 96 hours. A comparison can be made with the portable fish bioassay system belonging to the State of Tennessee. The State laboratory averaged less than 10 bioassays/yr compared to the 160 tests made by the Chattanooga plant laboratory in less than 6 months with the Microtox. While detailed analyses will still be required for some industrial wastes using sophisticated instrumentation, the Microtox will enable the manager to exempt many other dischargers from more costly procedures. (See also W88-00963) (Lantz-PTT)
W88-01004

ASSESSMENT OF SOIL LEAD PERIPHERAL TO A SMELTER AND PESTICIDE RESIDUES ON-SITE OF A DEFUNCT CHEMICAL PLANT,
Prairie View A and M Univ., TX. Coll. of Agriculture.
For primary bibliographic entry see Field 5B.
W88-01007

CADDO RIVER WATERSHED - HYDROMETEOROLOGY AND RUNOFF WATER QUALITY ANALYSIS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
H. E. Westerdahl, and E. R. Perrier.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 70-101, 8 fig, 11 tab, 19 ref.

Descriptors: *Caddo River, *Watersheds, *Hydrometeorology, *Runoff, *Water quality, *Rainfall-runoff relationships, *Arkansas, *Water analysis, Monitoring, Statistical analysis, Storms, Highways, Streamflow, Alkalinity, Turbidity, Temperature.

The statistical analysis of the 26 water quality loading parameters for the 13 storm events using 479 grab samples from the Caddo River watershed showed that functional relations were obtainable with acceptable standard errors of estimate. Discriminant analysis demonstrated that the loading characteristics observed at the Glenwood and Highway 84 bridge were not significantly different; thus, permitting bivariate and multiple regression analysis on the combined data set. As streamflow, alkalinity, turbidity, and stream temperature can be measured onsite, the prediction of certain chemical loadings can be accurately calculated using multiple regression. All 25 water quality parameters were analyzed using bivariate regression equations of water quality parameters versus flow. The upstage and downstage bivariate relations showed the 'first flush' phenomenon as an important indicator for stream loading. In general, the metals (except potassium) loaded on the recession part of the hydrograph suggesting the influence of groundwater loading. The nutrients, fecal coliform, and fecal streptococci were better related to the upstage of the hydrograph where the effects of management of urban development, farms, and forests could be noted early during the storm event. A great many complex relations added to the measured variance of a specific water quality parameter but the major contributing factors were the stochastic properties of rainfall, nonuniform loading relations (sodium for example), and loading peaks not matching hydrography peaks. (See also W88-01056) (Lantz-PTT)
W88-01059

BACTERIAL INDICATORS OF WATER QUALITY FROM SOUTHWEST ARKANSAS RESERVOIRS: DEGRAY LAKE,
Henderson State Univ., Arkadelphia, AR.
For primary bibliographic entry see Field 2H.
W88-01072

MONITORING AND ASSESSMENT TECHNIQUES,
Vermont Univ., Burlington. School of Natural Resources.
For primary bibliographic entry see Field 7A.
W88-01084

URBAN RUNOFF POLLUTANT INPUTS TO NARRAGANSETT BAY: COMPARISON TO POINT SOURCES,
Rhode Island Dept. of Environmental Management, Providence. Narragansett Bay Project.
For primary bibliographic entry see Field 5B.
W88-01112

INFLUENCE OF NPS POLLUTION IN FLORIDA ESTUARIES: A CASE STUDY,
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 5B.
W88-01114

ECOSYSTEMS THEORY AND THE UNEXPECTED: IMPLICATIONS FOR ENVIRONMENTAL TOXICOLOGY,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5C.
W88-01365

DEVELOPMENT OF NEW BIOASSAY PROTOCOLS,
Battelle Columbus Labs., OH. Environmental and Health Sciences Section.
K. M. Duke, and R. G. Merrill.
IN: Management of Toxic Substances in Our Ecosystems: Taming the Medusa. Ann Arbor Science, Ann Arbor, MI. 1981. p 101-120, 1 fig, 4 tab, 23 ref.

Descriptors: *Toxic wastes, *Hazardous wastes, *Bioassay, *Pollutant identification, *EPA Phased Approach, *Data acquisition, *Monitoring, Assay, Chemical properties, Biological properties, Physical properties, Economic aspects, Costs, Sampling, Sample preparation, Fluidized bed process.

The phased approach developed by the Environmental Protection Agency (EPA) for obtaining the data necessary for the design of pollution control technology programs involves three phases which allow reduction in cost without decrease in accuracy or reliability of the data. The initial phase (Level 1) acts as a screen using 'grab' samples and simple tests for the cost-effective measurement of the basic chemical, physical and biological characteristics of each waste stream. The Level 1 biological testing protocol and its implementation in selected EPA environmental assessment programs is detailed. Level 1 sample collection, transport and preparation procedures are described and the biological tests used at this level for the determination of health and ecological effects are reviewed. An example of a major EPA environmental assessment program to which Level 1 of the phased approach was applied, the study of the fluidized bed combustion process, is presented. Levels 2 and 3 bioassay protocols are still under development but will involve more detailed sampling and analyzing of the higher priority streams and monitoring of specific pollutants. (See also W88-01362) (Wood-PTT)
W88-01367

CENTERS FOR DISEASE CONTROL'S HUMAN HEALTH ASSESSMENT APPROACH INVOLVING IMPROPERLY DISPOSED CHEMICAL WASTE,
Centers for Disease Control, Atlanta, GA.
For primary bibliographic entry see Field 5C.
W88-01387

METHODS FOR ASSESSING HEALTH RISKS IN POPULATIONS LIVING NEAR HAZARDOUS WASTE SITES,
Roswell Park Memorial Inst., Buffalo, NY.
For primary bibliographic entry see Field 5C.
W88-01389

BIOINDICATORS FOR THE HEAVY METAL LOAD OF RIVER ECOSYSTEMS,
Bayerische Landesanstalt fuer Wasserforschung, Munich (Germany, F.R.).
B. Wachs.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 179-188, 3 fig, 18 ref.

Descriptors: *Heavy metals, *Bioindicators, *Aquatic plants, *Aquatic animals, *Bioaccumulation, *Path of pollutants, Fish, Ecosystems, Benthos, Sediments, Water pollution effects, Biological magnification, Monitoring, Water pollution sources, Rivers.

In river ecosystems, sediments show the highest accumulation factors of all potential sample materials for heavy metals. Continuous sampling of water must be carried out to detect average metal concentrations in this media. The absolute levels of the most important metals in fish muscle decrease in the following order: Zn >> Cu > Pb > or = Hg >> Cd. Fish which are end members of the aquatic food chain cannot serve as sensitive indicators of the metal load of river ecosystems. Their muscle tissue shows lower metal concentrations than zoobenthic organisms. Metal ions or compounds in solution are available for biota by adsorption on the surface of organisms and by translocation into the cells. The metal concentrations in biological material collected at the same sampling site can fluctuate widely. Well-founded average values of bioconcentration are obtained by carrying out measurements over a period of 1-2 yr with

a sampling frequency commensurate with the temporal stability of metal contamination, but with at least one investigation per month. The preventive protection of natural waters requires comprehensive knowledge of the distribution patterns of contaminants in the aquatic biota. (See also W88-01460) (Geiger-PTT)
W88-01476

TROUTS (SALMO GAIRDNERI RICH.) AS BIOINTEGRATORS FOR POLLUTANTS, A NEW METHOD OF RECORDING POLLUTANTS,
Forschungsinstitut fuer Mikrobiologie und Hygiene, Bad Elster (German D.R.).
For primary bibliographic entry see Field 5C.
W88-01482

5B. Sources Of Pollution

ASSESSMENT OF SOIL LEAD PERIPHERAL TO A SMELTER AND PESTICIDE RESIDUES ON-SITE OF A DEFUNCT CHEMICAL PLANT,
Prairie View A and M Univ., TX. Coll. of Agriculture.
E. Brams.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 429-437, 5 fig, 7 tab, 10 ref.

Descriptors: *Lead, *Water pollution effects, *Soil contamination, *Pesticides, *Fate of pollutants, *Case studies, Chemical wastes, Industrial wastes, Path of pollutants, Environmental effects, TOxicity, Lead.

Soil pollution was studied in two geographical areas that have been adulterated with toxic substances. Case I (area I) concerns adulteration of soil with lead within a 1-mile radius of a lead smelter located in an urban ecosystem. Case II (area 2) considers the assessment of pesticide residues that have accumulated for 40 yr in the soil of a defunct pesticide plant which now is sited for an office building complex. In case study I, the areal boundaries delineating soil in the survey area having 900 ppm Pb (the midpoint concentration of the class) are identified as only 1.5% of the total survey area and contain an estimated 24,390 pounds (10,976 kg) of Pb. The amount of Pb in this class alone exceeds the EPA limit as a 'reportable hazardous discharge' by a factor of 5. Although the EPA had set 1000 ppm soil Pb as the threshold level above which human health would be adversely affected, particularly in children as manifest by blood levels exceeding 30 micrograms Pb/dl blood, it is felt that a lower concentration of soil Pb in the 0.5-7.5 cm column, not to exceed 600 ppm should be established as the threshold level. The number of people living in the survey area who could possibly be harmed by soil Pb was estimated at 2,688. In case study II, calculations provided the concentration estimates of specific toxicants in equilibrium with the ambient solution at the time of sampling. Using the example of toxaphene, the estimated equilibrium concentration is calculated at 6.04 ppm. The EPA limit in water is 0.005 ppm. Thus, the estimated toxaphene concentration in ambient solution is 1208 times higher than the EPA limit. The estimated concentrations in ambient soil solution for the remaining toxicants are listed in tabular form, as are estimates of the concentration-class distribution of toxaphene over the site. For example, a concentration-class midpoint of 7.5 micrograms/gm in the soil induces an equilibrium concentration of 0.42 ppm in the ambient soil solution over 8.5% of the site. The assessment indicates that the site is hazardous to human health and should be isolated until reclaimed. (Lantz-PTT)
W88-01007

SMALL-SCALE FIELD EVALUATIONS OF LAND TREATMENT OF AN OILY HAZARDOUS WASTE,
Robert S. Kerr Environmental Research Lab., Ada, OK.
For primary bibliographic entry see Field 5D.
W88-01008

BACTERIAL INDICATORS OF WATER QUALITY FROM SOUTHWEST ARKANSAS RESERVOIRS: DEGRAY LAKE,
Henderson State Univ., Arkadelphia, AR.
For primary bibliographic entry see Field 2H.
W88-01072

HETEROGENEITIES AND WATER QUALITY - UNDERSTANDING DEGRAY LAKE WATER QUALITY THROUGH SAMPLING,
Ford, Thornton, Norton and Associates Ltd., Little Rock, AR.
For primary bibliographic entry see Field 2H.
W88-01077

PERSPECTIVES ON NONPOINT SOURCE POLLUTION.
Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. 514 p.

Descriptors: *Nonpoint pollution sources, *Conferences, *Information exchange, *Water pollution sources, Data acquisition, Chesapeake Bay.

This conference was conceived as an integral part of the Environmental Protection Agency's approach to nonpoint source pollution. The other three components which are discussed in this volume are: ASIWPCA's survey of the States, the Federal Nonpoint Source Task Force (which concluded its initial policy and strategy development at the end of 1984), and the Chesapeake Bay study now underway by the National Association of Conservation Districts. The conference purposes were fourfold: (1) focus on drawing information from everybody involved with the problem; (2) find out how people throughout the country, at the local level, perceive the nonpoint source problem and how they believe it should be handled; (3) make the information flow from the grass roots upward - the Federal role was to listen and learn and exchange information, not to dominate; and (4) make it practical. Four basic themes evolved as the conference developed: (1) practical affordable solutions not imposed by Federal authority but worked out at the local level; (2) The knowledge exists; (3) nonpoint source pollution is best solved at the local level; and (4) cooperation is the key. (See W88-01084 thru W88-01185) (Lantz-PTT)
W88-01083

LAND USE MONITORING AND ASSESSMENT FOR NONPOINT SOURCES POLLUTION CONTROL,
Vermont Univ., Burlington. School of Natural Resources.
For primary bibliographic entry see Field 5G.
W88-01085

APPROPRIATE DESIGNS FOR DOCUMENTING WATER QUALITY IMPROVEMENTS FROM AGRICULTURAL NPS CONTROL PROGRAMS,
National Water Quality Evaluation Project.
For primary bibliographic entry see Field 7A.
W88-01086

MONITORING FOR WATER QUALITY OBJECTIVES IN RESPONSE TO NONPOINT SOURCE POLLUTION,
Environmental Protection Service, Regina (Saskatchewan). Water Quality Branch.
For primary bibliographic entry see Field 7A.
W88-01087

USE OF BIOASSAYS TO DETERMINE POTENTIAL TOXICITY EFFECTS OF ENVIRONMENTAL POLLUTANTS,
Corvallis Environmental Research Lab., OR. Hazardous Waste and Water Branch.
For primary bibliographic entry see Field 7A.
W88-01088

GROUND WATER CONTAMINATION BY ALDICARB PESTICIDE IN EASTERN SUFFOLK COUNTY, LONG ISLAND,
Geological Survey, Syosset, NY. Water Resources Div.
J. Soren, and W. G. Stelz.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 101-108, 5 fig, 3 tab, 18 ref.

Descriptors: *Groundwater pollution, *Aldicarb, *Long Island, *Suffolk County, *Path of pollutants, *Pesticides, Agriculture, Fate of pollutants, Drinking water, Groundwater quality.

Highly toxic aldicarb pesticide, initially considered incapable of contaminating groundwater, was used on about 9,700 ha of potato fields in eastern Suffolk County on Long Island, N.Y., during 1975-79. In 1979, aldicarb was found in substantial concentrations in groundwater samples. Subsequent extensive analyses of the area's groundwater showed widespread contamination, with concentrations ranging from traces to as much as 515 micrograms/L. The New York State Department of Health has set a limit for aldicarb in drinking water at 7 micrograms/L, and, in early 1980, the U.S. Environmental Protection Agency revoked its approval for the use of aldicarb on Long Island. In 1980, a total area of about 198 sq km, nearly four times the area to which aldicarb has been applied, contained small to excessive aldicarb concentration sin groundwater; a 54 sq km area, approximately half of the area to which aldicarb had been applied, contained excessive concentrations. By 1984, aldicarb's manufacturer had installed more than 2,000 activated charcoal filters on drinking water supply well systems with excessive aldicarb concentrations to reduce concentration to less than 7 micrograms/L, and agreed to continue the filter installations as needed. Despite aldicarb's reputed toxicity, no case of aldicarb poisoning from drinking water on Long Island has been documented. The aldicarb may remain within the system for decades. Its duration in the soil and groundwater is under investigation. Estimates of its 'half-life' range from 2 years to as much as 10 years. Current estimates of aldicarb's deterioration on Long Island suggest that concentration may decline to less than 7 micrograms/L between 1990 and 2030. (See also W88-01083) (Author's abstract)
W88-01102

NONPOINT SOURCE CONTAMINATION OF GROUND WATER IN KARST-CARBONATE AQUIFERS IN IOWA,
Iowa State Geological Survey, Iowa City.
G. R. Hallberg, R. D. Libra, and B. E. Hoyer.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 109-114, 3 fig, 3 tab, 13 ref.

Descriptors: *Path of pollutants, *Groundwater pollution, *Nonpoint pollution sources, *Iowa, *Karst, Aquifers, Carbonates, Fate of pollutants, Infiltration, Nitrites, Herbicides, Agricultural runoff, Fertilizers, Groundwater quality, Monitoring.

There are two components of groundwater recharge in karst-carbonate aquifer systems: (1) conventional infiltration, and (2) the direct entry of surface water through sinkholes. Thus, in karst areas the better known problems of nonpoint source pollution, associated with the runoff of sediment and chemicals from agricultural land into surface waters, directly merge with the groundwater system and the poorly-understood problems of the infiltration of agricultural chemicals. Three years of detailed water quality monitoring and water, mass balance studies show: (1) during major surface-runoff events high concentration of suspended sediment, pesticides, and bacteria enter the groundwater and move as a 'slug' through the carbonate aquifer, creating brief, but acute water quality problems; but, (2) over a water year the infiltration component delivers to groundwater the greatest mass and highest concentrations of NO3, and the greatest mass of the pesticides detected.

Many of the more widely used herbicides are detected commonly in groundwater, and are now present year-round. The amount of NO3-N discharged in groundwater and surface water per year, from a 267 cu km study basin, has equaled about 30-50% of the fertilizer-N applied, an economic as well as an environmental concern. (See also W88-01083) (Author's abstract)
W88-01103

INTERDISCIPLINARY APPROACH TO SHALLOW GROUND WATER CONTAMINATION IN NORTH-CENTRAL MONTANA,
Triangle Conservation District, Conrad, MT.
For primary bibliographic entry see Field 5G.
W88-01104

MONITORING THE EFFECTS TO THE GROUND WATER SYSTEM ATTRIBUTABLE TO AGRICULTURAL PRACTICES,
South Dakota Dept. of Water and Natural Resources, Pierre.
For primary bibliographic entry see Field 7A.
W88-01106

URBAN NONPOINT SOURCE IMPACTS ON A SURFACE WATER SUPPLY,
For primary bibliographic entry see Field 5C.
W88-01107

URBAN RUNOFF POLLUTANT INPUTS TO NARRAGANSETT BAY: COMPARISON TO POINT SOURCES,
Rhode Island Dept. of Environmental Management, Providence. Narragansett Bay Project.
E. J. Hoffman.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 159-164, 2 fig, 3 tab, 17 ref.

Descriptors: *Estuaries, *Water pollution sources, *Narragansett Bay, *Nonpoint pollution sources, *Urban runoff, *Pollutant identification, Industrial wastes, Rainfall-runoff relationships, Highway runoff, Pollutant load, Suspended solids, Aromatic compounds, Hydrocarbons, Zinc, Lead, Copper, Heavy metals.

Urban runoff samples were collected from four drains, each serving a different land use: residential, commercial, highway, and industrial. Twenty-one storm events were monitored to establish mass discharge rates of water volume, suspended solids, petroleum hydrocarbons, polycyclic aromatic hydrocarbons, and a variety of trace metals, as a function of storm rainfall and land use. These loading rates were combined with local rainfall and land use records to estimate annual urban runoff inputs to the Narragansett Bay watershed. For comparison a point source inventory for the same components though self-monitoring reports and past monitoring studies conducted at the university was compiled, augmented with additional analyses as required. Urban runoff was found to be the source of 48% of the petroleum hydrocarbons, 3% of the lower molecular weight (2 ring) polycyclic aromatic hydrocarbons, 44% of the higher molecular weight polycyclic aromatic hydrocarbons, 65% of the lead, 56% of the zinc, and 5% of the copper entering the Narragansett Bay watershed annually. The application of the urban runoff loading rates was tested on one of the Narragansett Bay tributaries, the Pawtuxet River. The wet-weather related mass discharge rates for these constituents in the river, as monitored during and following one storm event, was estimated within a factor of 2 using loading factors with the rainfall and local land use data. The fate and transport of wet-weather components in the Narragansett Bay estuary will be examined as part of the Narragansett Bay Project of the EPA National Estuaries Program. (See also W88-01083) (Author's abstract)
W88-01112

CHESAPEAKE BAY NONPOINT SOURCE POLLUTION,
Chesapeake Bay Liaison Office, Annapolis, MD.
J. Macknis.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 165-171, 4 fig, 3 tab, 2 ref.

Descriptors: *Chesapeake Bay, *Nonpoint pollution sources, *Water pollution sources, *Water quality management, *Water pollution control, Model studies, Phosphorus, Nitrogen, Path of pollutants, Simulation analysis, Water quality control.

In 1976, the EPA was directed by Congress to conduct an in-depth study of the Chesapeake Bay, its resources and its management. The goal was 'to protect and preserve the quality of the Chesapeake Bay by effectively managing its uses and resources.' In completing the $27 million study, the EPA Chesapeake Bay Program developed a watershed model to estimate point and nonpoint source loadings to the Bay and to evaluate management strategies in reducing nutrient loadings. Model production runs indicate that nonpoint sources contribute between 31 and 64% of the phosphorus load and between 62 and 81% of the nitrogen load to the Bay system depending upon annual rainfall conditions. Most of the phosphorus loadings to Chesapeake Bay come from point sources which are concentrated close to tidal waters, while most of the nitrogen enters the Bay from nonpoint sources located throughout the basin, primarily runoff from agricultural croplands. Model simulations indicate that a Level II best management practice such as conservation tillage is a cost-effective management alternative. In response to the findings of the Chesapeake Bay Program, the Bay States of Maryland, Pennsylvania, and Virginia initiated agricultural (and urban) nonpoint source control programs that increase technical and financial assistance to farmers and augment demonstration projects and education efforts. The Program is tracking these efforts and attempting to evaluate their effectiveness in controlling nonpoint source pollution. (See also W88-01083) (Author's abstract)
W88-01113

INFLUENCE OF NPS POLLUTION IN FLORIDA ESTUARIES: A CASE STUDY,
Florida State Dept. of Environmental Regulation, Tallahassee.
J. Ryan, and J. H. Cox.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 172-176, 4 fig, 1 tab, 17 ref.

Descriptors: *Nonpoint pollution sources, *Florida, *Estuaries, *Case studies, *Fate of pollutants, *Pollutant identification, Organic compounds, Heavy metals, Miami River, Biscayne Bay, Cadmium, Mercury, Copper, Lead, Silver, Zinc, Water pollution sources.

A study designed to characterize the pollutant climate of 13 major bays and estuaries in Florida was carried out by examining sediment chemistry. This study provided improved interpretive tools that were used to distinguish natural versus anthropogenic metal concentrations and to help identify nonpoint sources. Results confirmed that although elevated metals and synthetic organic compounds were present in the water column, the concentration of these constituents was well below State and EPA water quality standards. These data provide a clearer understanding of pollutant trends and revealed encroachment of metal contamination in several major estuaries. The highest levels of metals and synthetic organics were found in sediments from the Miami River and Biscayne Bay. The river receives pollutants - particularly Ag, Cd, Cu, Hg, Pb, and Zn - from a variety of nonpoint sources originating from the adjacent city of Miami. The river essentially becomes a point source discharging moving contaminants into the Bay. Results from the study were used as a basis for making recommendations to State and Federal agencies for cleaning up nonpoint sources entering the Miami River. (See also W88-01083) (Author's abstract)
W88-01114

SHELLFISH SANITATION IN OREGON: CAN IT BE ACHIEVED THROUGH POLLUTION SOURCE MANAGEMENT,
Oregon State Dept. of Environmental Quality, Portland.
For primary bibliographic entry see Field 5G.
W88-01116

MONITORING CHANGES IN AGRICULTURAL RUNOFF QUALITY IN THE LAPLATTE RIVER WATERSHED, VERMONT,
Vermont Univ., Burlington. School of Natural Resources.
For primary bibliographic entry see Field 5G.
W88-01117

NONPOINT SOURCE POLLUTION IN THE RICE CREEK WATERSHED DISTRICT - THE RESULTS OF 10 YEARS OF WATER QUALITY MONITORING,
Hickok (Eugene A.) and Associates, Inc., Wayzata, MN.
For primary bibliographic entry see Field 5G.
W88-01118

PESTICIDE MONITORING IN KANSAS SURFACE WATERS: 1973-1984,
Kansas Dept. of Health and Environment, Topeka. Div. of Environment.
M. K. Butler, and J. A. Arruda.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 196-200, 4 fig, 4 tab, 10 ref.

Descriptors: *Pollutant identification, *Path of pollutants, *Pesticides, *Nonpoint pollution source, *Kansas, *Monitoring, Water quality, Alachlor, Atrazine, Fate of pollutants, Agricultural runoff.

Routine monitoring of Kansas surface waters began in 1973 with a network of 11 sites and continued in 1984 with $>$ 100 fixed stream sites and $>$ 40 rotating lake sites. A change in detection limits in 1977 led to a dramatic increase in the number of pesticides detected. Since 1977, the most consistently found pesticides in stream samples have been atrazine (17%), alachlor (5%), 2,4-D (4%) and Dual (4%). Lake sampling sites revealed the same pattern. Although recent numbers of detections and concentration levels are higher than earlier in the program, a clear temporal pattern is not evident. There are, however, clear patterns in the location where the pesticides are routinely found. Eastern Kansas streams and lakes show the most consistent patterns of pesticide detection, probably related to use and runoff conditions. Pesticides have also been found in treated drinking water that originated from lake water. Treatment reduced concentrations about one-third from those found in the raw lake water. (See also W88-01083) (Author's abstract)
W88-01119

EFFECTS OF INTENSIVE AGRICULTURAL LAND USE ON REGIONAL WATER QUALITY IN NORTHWESTERN OHIO,
Heidelberg Coll., Tiffin, OH. Water Quality Lab.
For primary bibliographic entry see Field 4C.
W88-01120

CONTROLLING WATER POLLUTION FROM NONPOINT SOURCE LIVESTOCK OPERATIONS,
Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5G.
W88-01121

IDENTIFYING CRITICAL NPS CONTRIBUTING WATERSHED AREAS,
FTN Associates, Little Rock, AR.
K. W. Thornton, and D. E. Ford.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Pro-

tection Agency, 1985. p 247-250, 2 fig, 14 ref.

Descriptors: *Water pollution control, *Water pollution sources, *Water quality control, *Nonpoint pollution sources, Watersheds, Sediments, Nutrients, Pesticides, Erosion, Water quality management.

By general agreement, nonpoint source contribute significantly to receiving system water quality problems. Sediment is the greatest pollutant both by weight and volume. Nutrients, pesticides, and other constituents may be adsorbed to sediment particles and transported to the receiving system through erosion. Best management practices (BMP's) are usually expensive to implement; however, they do not have to be implemented throughout the entire watershed to control NPS. In many watersheds, certain critical areas contribute the majority of the pollutants. Identifying these areas permits the most efficient implementation of BMP's and the most economical approach for controlling NPS. Eleven major steps in identifying these critical areas are discussed. These range from identifying the physiographic characteristics through cost/benefit analysis and implementation of BMP's. This approach forms the base for nutrient, organic, or other mass loading. An example from a rural watershed is given. (See also W88-01083) (Author's abstract)
W88-01128

GROSS EROSION RATES, SEDIMENT YIELDS, AND NUTRIENT YIELDS FOR LAKE ERIE TRIBUTARIES: IMPLICATIONS FOR TARGETING,
Heidelberg Coll., Tiffin, OH. Water Quality Lab.
D. B. Baker, K. A. Krieger, R. P. Richards, and J. W. Kramer.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 251-255, 7 tab, 20 ref.

Descriptors: *Water pollution sources, *Erosion rates, *Sediment yield, *Nutrients, *Lake Erie, *Nonpoint pollution sources, Phosphorus, Sediments, Nitrogen, Agricultural runoff.

Studies of agricultural nonpoint pollution in selected watersheds within the Lake Erie Basin have included estimates of gross erosion rates, as well as measurements of sediment, phosphorus and nitrogen yields. These studies indicate that under conventional management practices average gross erosion rates for watersheds are not reliable indicators of the export of either soluble or sediment associated pollutants. Average gross erosion rates are not even good indicators of sediment yields. Consequently, factors other than gross erosion need to be considered in watershed level targeting for agricultural pollution abatement programs. (See also W88-01083) (Author's abstract)
W88-01129

AGRICULTURAL SOURCES OF NITRATE CONTAMINATION IN A SHALLOW SAND AND GRAVEL AQUIFER OF EASTERN SOUTH DAKOTA,
South Dakota Dept. of Water and Natural Resources, Pierre.
J. Goodman.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 264-267, 4 fig, 4 ref.

Descriptors: *Agricultural runoff, *Water pollution sources, *Nitrates, *Aquifer, *South Dakota, *Nonpoint pollution sources, Big Sioux aquifer, Water quality, Water sampling, Path of pollutants, Monitoring, Fertilizers.

The South Dakota Department of Water and Natural Resources initiated a water quality study of the Big Sioux aquifer in eastern South Dakota because of growing concerns over potential water quality degradation in the aquifer. Reports of unacceptable levels of nitrates (> 10 mg/L NO3-N) in 25% of available domestic well samples and in several community water systems were of particular concern. A random sampling network was established to characterize the general water quality of the aquifer. Results of the random network sampling indicated nitrate contamination was generally confined to numerous localized rather than widespread areas. Specifically, 37% of 27 domestic well samples exceeded the United States Environmental Protection Agency (EPA) drinking water limit of 10 mg/L NO3-N. The major agricultural sources of nitrates were animal wastes from feedlots and accidental releases of fertilizers, with the contamination problems compounded by improper well construction and poor location. Two special studies were conducted near rural community water supplies contaminated with excessive concentrations of nitrates. Monitoring in the Egan, South Dakota, area indicated contamination with concentrations reaching 240 mg/L NO3. The source of contamination was determined to be leaking liquid fertilizer tanks near the city well. Monitoring in Elkton, South Dakota, also indicated the most likely source of contamination was a fertilizer distributor. A plume of contamination was defined with a high concentration of 67 mg/L NO3-N in a well near the distributor. Because of these findings, a public education program was initiated as part of the Big Sioux Aquifer Water Quality Study. This program focused on nitrate contamination sources, means of contamination prevention, and recommendations for well construction and location. (See also W88-01083) (Author's abstract)
W88-01132

ACCUMULATION OF SEDIMENT, NUTRIENTS, AND CESIUM-137 IN PRAIRIE POTHOLES IN CULTIVATED AND NONCULTIVATED WATERSHEDS,
Fish and Wildlife Service, Yankton, SD.
For primary bibliographic entry see Field 4C.
W88-01134

IRRIGATED AGRICULTURE AND NONPOINT SOURCE POLLUTION IN THE SAN JOAQUIN VALLEY OF CALIFORNIA,
Westlands Water District, Fresno, CA.
W. R. Johnston.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 276-278, 1 fig, 7 ref.

Descriptors: *Water pollution control, *Irrigation practices, *Nonpoint pollution sources, *San Joaquin Valley, *California, *Water quality control, Irrigation water, Drainage, Saline water, Salinity, Regulations, Permits.

Nonpoint source pollution related to irrigated agriculture is becoming a significant problem in regard to maintaining high water quality in California, and particularly in the San Joaquin River Basin where large quantities of saline subsurface agricultural drainage water are produced. The problem will occur eventually in any irrigated area where subsurface drainage problems develop and where no readily available salt sink exists to dispose of the saline subsurface drainage water. Four major types of nonpoint source pollution generally emanate from irrigated agriculture. They are: (1) sediments, (2) pesticides; (3) nitrates; and (4) salinity, including minor elements. Frequently, on-farm Best Management Practices (BMP's) can control nonpoint source pollution problems without causing serious impacts on farm production or the environment. However, saline subsurface agricultural drainage water may contain little, if any, sediments or pesticides, but significant amounts of salts, nitrates, and heavy metals or other toxic elements. In such instances, otherwise feasible BMPs are difficult and economically and environmentally impractical to implement on-farm. Such is the situation in the San Joaquin VAlley of California. However, when approximately 15.24 ha-cm/ha (0.5 acre-ft/acre) of saline drainage water is produced on a 365-day/yr production cycle, then each farmer must be prepared to manage about 616.8 cu m (21,780 cu ft) of drain water for each ha (acre) of farmland drained. The water could cause substantial environmental problems, if not properly managed. In some cases, mismanagement of the water would threaten wildlife or human health. Rules and regulations, permit considerations, and salt management of irrigation water and practices are fully discussed here regarding how these points can aid in regulating drainage water quality and quantity. (See also W88-01083) (Lantz-PTT)
W88-01135

FACTORS AND TREATMENT OF ABANDONED ACID MINE LANDS FOR CONTROLLING NONPOINT SOURCE POLLUTION,
Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.
For primary bibliographic entry see Field 5G.
W88-01143

PHOSPHATE AND PEAT MINING IN FLORIDA,
Saint Johns River Water Management District, Palatka, FL.
For primary bibliographic entry see Field 4C.
W88-01147

WATER QUALITY PROBLEMS CAUSED BY ABANDONED METAL MINES AND TAILINGS,
Missouri Dept. of Natural Resources, Jefferson City.
For primary bibliographic entry see Field 5C.
W88-01148

SALINITY: NONPOINT SOURCE PROBLEM IN THE COLORADO RIVER BASIN,
Bureau of Reclamation, Denver, CO. Colorado River Water Quality Office.
A. R. Jonez.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 352-355, 4 fig.

Descriptors: *Water pollution sources, *Colorado River, *Salinity, *Water quality control, Salts, Costs, Economic aspects, Nonpoint pollution sources, Water pollution control, Big Sandy River, Price River, San Rafael River, River basins.

One of the many forms of nonpoint source pollution is salinity. This pollution is causing millions of dollars in damages in the Colorado River Basin. Three specific areas of nonpoint source salinity pollution in the Basin and the progress which has been made toward controlling it are discussed. The three areas are near the Big Sandy River in Wyoming, in the Price-San Rafael River Basins, and in the Dirty Devil River Basin in Utah. Source areas, plans for controlling salinity inflow, and benefits, cost-effectiveness, and issues regarding the plan are briefly explored. (See also W88-01083) (Author's abstract)
W88-01150

SALINITY CONTROL IN THE GRAND VALLEY OF COLORADO,
Grand Valley Salinity Program, Grand Junction, CO.
For primary bibliographic entry see Field 5G.
W88-01152

IMPACT OF NONPOINT SOURCE FECAL LOADING ON BACKCOUNTRY WATERS IN GRAND CANYON,
Arizona Univ., Tucson. School of Renewable Natural Resources.
B. Tunnicliff, and S. K. Brickler.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 374-379, 3 fig, 1 tab, 24 ref.

Descriptors: *Water pollution sources, *Feces, *Colorado River, *Grand Canyon, *Nonpoint pollution sources, Rainfall, Environmental effects, Coliforms, Rainfall.

Contrary to some popular opinions regarding pristine natural environments, examination of recreational water quality in Grand Canyon National Park has revealed two naturally occurring, and potentially health threatening, nonpoint sources of fecal loads in Colorado River and tributary stream waters. Following monsoon type rainfall events, fecal loading of the river, as indicated by fecal coliform (FC) densities, exceeded the recreational primary contact standard, 200 FC/100 mL. In contrast, during extensive drought periods, mean FC densities in the river and tributaries were 10 and 20 FC/100 mL, respectively. Fecal sources in the Grand Canyon watershed include wildlife, some livestock, and dispersed recreation. (See also W88-01083) (Author's abstract)
W88-01155

HIGHWAY RUNOFF/DRAINAGE IMPACTS,
Federal Highway Administration, McLean, VA.
B. N. Lord.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 387-390.

Descriptors: *Water pollution control, *Nonpoint pollution sources, *Highway runoff, *Water pollution effects, *Fate of pollutants, Environmental effects, Highway drainage, Water pollution sources, Stormwater runoff, Pollutant identification, Guidelines, Economic aspects.

The Federal Highway Administration has undertaken a four-phased research program on nonpoint source pollution from highway operations. The objectives of this program are to characterize highway stormwater runoff; identify sources, mechanisms of transport, and fate of pollutants within the right-of-way; determine the magnitude and extent of impacts to receiving waters; and develop guidelines to implement cost-effective measures to protect water resources. A multistudy program has developed a significant national highway stormwater runoff data base. The objective of these studies was to identify and quantify pollutants found in runoff from operating highways. Research is underway to develop a design procedure to predict pollutant loading from highways. This study also identified factors that influence the transport and fate within the right-of-way. Results of this research were used to identify cost-effective measures to minimize impacts. An extensive receiving water study has investigated the effects of highway runoff on receiving water environment. Guidelines were developed for assessing water resources impacts from highways. An evaluation and synthesis of nonpoint source runoff mitigation has identified cost-effective measures for highway stormwater and guidelines to assist highway agencies in identifying potential problems and implementing mitigation. An important product of this study was identification of ineffective measures. Research is underway to develop performance criteria and design specifications for retention, detention, and overland flow systems. A highway runoff training program is being prepared to transfer the technology developed from this program. (See also W88-01083) (Author's abstract)
W88-01158

AGRICULTURAL NONPOINT SOURCE STUDIES IN SOUTHEASTERN WATERSHEDS: FIELD MONITORING AND FARMER SURVEYS,
North Carolina State Univ. at Raleigh.
F. J. Humenik.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 402-407, 4 tab, 10 ref.

Descriptors: *Path of pollutants, *Water pollution control, *Nonpoint pollution sources, *Monitoring, *Water quality, Nitrogen, Phosphorus, Sediment load, Water quality management, Fate of pollutants.

Annual nitrogen, phosphorus and sediment loadings for 2 to 4 years of field sampling in three geographic regions of North Carolina are presented. Predictive equations developed to expand the concentration data for use with the more complete flow record to calculate annual loading rates are described. Comparisons between the five Coastal Plain, six Piedmont, and one mountain watershed, and with literature values are made. Producer surveys were conducted 4 years for the Coastal Plain study and 2 years for the Mountain study. Questions were designed to evaluate farmer awareness of technical and cost-sharing assistance available. Information on attitudes concerning the need and adoption of best management plans to control nonpoint sources at the beginning and end of the study period was also collected. Results show the need for and challenges that exist for producer education and motivation to implement and maintain appropriate recommendations. Techniques are recommended for evaluating nonpoint source control program effectiveness or water quality changes over time and space based on experiences with judgmental and statistical grab and instrumental sampling, modeling techniques, and plot versus watershed studies. (See also W88-01083) (Author's abstract)
W88-01161

PROTECTING TILLAMOOK BAY SHELLFISH WITH POINT/NONPOINT SOURCE CONTROLS,
Oregon State Dept. of Environmental Quality, Portland.
For primary bibliographic entry see Field 5G.
W88-01165

FATE OF MATERIALS EXPORTED BY THE BIG BLUE AND THE BLACK VERMILLION RIVERS INTO TUTTLE CREEK RESERVOIR, KANSAS,
Kansas State Univ., Manhattan. Div. of Biology.
J. R. Shuman, G. R. Marzolf, and J. A. Arruda.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 471-477, 7 fig, 12 ref.

Descriptors: *Fate of pollutants, *Big Blue River, *Black Vermillion River, *Nonpoint pollution sources, *Suspended load, *Tuttle Creek Reservoir, *Kansas, Suspended sediments, Nutrients, Dissolved solids, Agricultural watersheds, Precipitation, Turbidity, Water quality, Biological processes.

Suspended sediments and dissolved nutrients in mid-western reservoirs originate in agricultural watersheds. Rivers carry the sediments and nutrients to reservoirs formed by impounded rivers. Highest loadings occur during storm flows, thus the hydrologic regime represents a significant control variable. Most of the precipitation in the Great Plains occurs in late spring and early summer, usually in the form of thunderstorms, but little similarity exists from year to year. Once in the reservoir, wind generated currents keep materials in suspension, thus establishing turbidity gradients along the long axis of the reservoir. These gradients of suspended materials control many biological processes, e.g., photosynthesis, decomposition, particulate feeding by zooplankton and predation by zooplanktivorous fishes. These biological processes influence water quality; thus, while the original quality of the water entering the reservoir is directly related to watershed conditions, watershed properties more subtly and indirectly influence water quality. (See also W88-01083)
W88-01176

INTERACTION OF BIOLOGICAL AND HYDROLOGICAL PHENOMENA THAT MEDIATE THE QUALITIES OF WATER DRAINING NATIVE TALLGRASS PRAIRIE ON THE KONZA PRAIRIE RESEARCH NATURAL AREA,
Savannah River Ecology Lab., Aiken, SC.
J. V. McArthur, M. E. Gurtz, C. M. Tate, and F. S. Gilliam.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 478-482, 5 fig, 1 tab, 14 ref.
DOE Contract No. E-AC09-76SR00819.

Descriptors: *Water quality, *Biological processes, *Hydrological processes, *Konza Prairie, *Kings Creek Watershed, Water chemistry, Chemical analysis, Data acquisition, Organic carbon, Nitrogen, Phosphorus, Particulate matter.

The quality of water from native landscapes is the baseline against which the impact of pollutants on surface water resources must be evaluated. The King's Creek watershed has been a U.S. Geological Survey benchmark watershed since 1979. It represents the landscape type that gave rise to much of the agricultural midwestern United States. Hydrologic, chemical, and biological measurements have been made by ecologists performing long-term ecological research (LTER) in tallgrass prairie. Streamwater chemistry varies seasonally with the amount and movement of groundwater and soil water, with changes in surface water discharge. Concentrations of organic carbon, organic and inorganic nitrogen, and phosphorus increase during storm flows. The particulate fractions in transport and in storage in the stream bed and on the flood plain vary seasonally with recent hydrologic history and changes in vegetation. (See also W88-01083)
W88-01177

IMPLICATIONS OF AIRSHED PROCESSES AND ATMOSPHERIC DEPOSITION OF NONPOINT POLLUTANTS,
Butler Univ., Indianapolis, IN. Holcomb Research Inst.
O. L. Loucks.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 483-486, 3 tab, 19 ref.

Descriptors: *Fallout, *Acid rain, *Air pollution, *Nonpoint pollution sources, *Lakes, *Fate of pollutants, *Minnesota, *Wisconsin, *Great Lakes, Chemical analysis, Path of pollutants, Sulfates, Hydrogen ion concentration, Alkalinity.

Lake managers now routinely use estimates of chemical loadings from adjacent land surfaces and from groundwater in evaluating prospective responses to a treatment. However, large nonpoint sources of pollutants through atmospheric transport and deposition also need to be considered. The capacity for watersheds and lakes to assimilate the acidic component of these inputs varies widely on a site-by-site basis. Results are presented from studies of atmospheric chemical inputs and associated lake chemistries in northern Minnesota and Wisconsin. Evidence is gradually documenting the lake-watershed properties that determine whether nonpoint pollutants deposited by atmospheric processes are likely to result in a pH or alkalinity depression in lakes or streams. When combined with computations on hydrology and lakewater renewal times, information also is being developed to determine whether the responses to SO4(2-) deposition in the northern Great Lakes States is emerging as the most important variable determining lake sulfate and alkalinity, and aspects of watershed hydrology, lakewater renewal times, and surrounding vegetation types are important secondary considerations. (See also W88-01083) (Lantz-PTT)
W88-01178

IRRIGATION RETURN FLOWS AND SALINITY PROBLEMS IN THE COLORADO RIVER BASIN,
World Resources Inst., Washington, DC.
For primary bibliographic entry see Field 5G.
W88-01180

AGRICULTURAL NONPOINT SOURCE POLLUTION IN THE MIDWEST,
Illinois Univ., Urbana. Coll. of Agriculture.
R. D. Walker.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Pro-

tection Agency, 1985. p 497-498.

Descriptors: *Agricultural runoff, *Nonpoint pollution sources, *Erosion, *Water pollution sources, Sedimentation, Soil erosion, Wind erosion, Conservation tillage, Pesticides, Herbicides.

The area often referred to as the North Central States and Northern Great Plains includes Ohio, Indiana, Illinois, Missouri, Iowa, Minnesota, Wisconsin, and Michigan as the North Central States, and Kansas, Nebraska, South Dakota, and North Dakota as the Northern Great Plains. These areas have the highest percent of land devoted to agricultural crops in the US. More than 60% of the total land is used to grow agricultural crops. The major crops are corn, soybeans, sorghum grains, and wheat; corn and soybeans are grown in the North Central States and wheat and sorghum grains in the Northern Great Plains States. Changes in agriculture have been occurring that cause higher levels of nonpoint pollution; primarily a shift from grasses and legumes to soybeans on a large portion of the Corn Belt land. A change in soil erosion occurred as a result of the shift. This problem changes from west to east in the area; with wind erosion the dominant problem in the Western Great Plains, changing to water erosion eastward into the North Central States. Water erosion is affected mainly by rainfall amounts, but also by soil types. Sediment is a major water pollutant, especially through the central Corn Belt of Indiana, Illinois, and Iowa. Sediment delivered to streams and lakes is also affected by the soil type and rainfall. The deep loess soils found along the Missouri, Mississippi, and Illinois Rivers are highly erosive, resulting in high sedimentation rates in lakes and rivers. A major soil erosion control practice that is now promoted to reduce soil erosion is conservation tillage. Conservation tillage systems include those reduced tillage systems that leave 20-30% crop residue soil cover after planting. The major environmental problem with these systems has been the increased dependence on pesticides, particularly herbicides to control weeds as tillage is reduced. While the systems are effective in reducing soil erosion by 50-80%, the long-term consequences of using the pesticides are not known. (Lantz-PTT) (See also W88-01083)
W88-01181

EFFECTS OF CARBONATE GEOLOGY ON URBAN RUNOFF: WATER QUALITY ASPECTS,
Tennessee Valley Authority, Chattanooga.
J. D. Milligan, and R. P. Betson.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 499-501, 1 fig, 2 tab, 4 ref.

Descriptors: *Carbonates, *Geology, *Urban runoff, *Water quality control, *Nonpoint pollution sources, *Knoxville, *Tennessee, *Path of pollutants, Rainfall, Runoff, Groundwater quality, Water pollution sources, Water quality.

A study of urban runoff in four subbasins within a Knoxville, Tenn., watershed was conducted as part of EPA's Nationwide Urban Runoff Program. The four subbasins represent three urban land-use types, residential, strip commercial, and central business district. Flow proportional runoff samples, rainfall, and dryfall samples were collected for water quality analysis. A water quality mass balance was used to differentiate the effect of different urban land use types and carbonate geology on urban runoff water quality. Rainfall/runoff load ratios illustrate the effect of carbonate geology on different water quality constituents within the subbasins and their potential impact on groundwater. Correlation coefficients between input/output ratios of conservative constituents and antecedent dry days were calculated; these further illustrate the relationship of carbonate geology to urban runoff. The seasonal nature of the magnitude of urban runoff losses to the groundwater system was evidenced by the retention of potential runoff mass within the subbasins during dry weather storms. It was found that urban runoff in areas underlain by carbonate geology may have a significant impact on groundwater quality. (See also W88-01083)
W88-01182

USING IN-STREAM MONITORING STATIONS TO EVALUATE POLLUTION FROM URBAN RUNOFF,
South Dakota School of Mines and Technology, Rapid City. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W88-01183

TRACE METALS IN THE ENVIRONMENT: VOLUME 6 - COBALT, AN APPRAISAL OF ENVIRONMENTAL EXPOSURE.
For primary bibliographic entry see Field 5C.
W88-01198

GEOCHEMISTRY AND OCCURRENCE,
Midwest Research Inst., Kansas City, MO.
B. L. Carson, and C. J. Cole.
IN: Trace Metals in the Environment: Volume 6 - Cobalt, An Appraisal of Environmental Exposure. Ann Arbor Science Publishers Inc., Ann Arbor, MI. 1981. p 371-529, 3 fig, 36 tab, 292 ref.

Descriptors: *Heavy metals, *Cobalt, *Geochemistry, *Pollutant identification, Igneous rocks, Metamorphic rocks, Minerals, Sediments, Marine environment, Phosphates, Water pollution, Water pollution sources.

The crustal abundance of cobalt has been calculated largely on the basis of concentrations in igneous and sometimes metamorphic rocks. The bulk of cobalt is in the more easily weathered minerals such as olivine, hornblende, augite, and biotite. Ilmenite and magnetite are moderately stable toward weathering action. The cobalt in the crystal lattice of rock-forming minerals is unavailable to other environmental media until released by weathering. In sediments of natural water bodies, the cobalt concentrations reported range from 9 mg/kg (sediments in the Sea of Japan) to 160 mg/kg (carbonate-free sediments deep in the Indian and Pacific Oceans). Phosphate, carbonate, and hydroxyl are the anions regulating the solubility of cobalt in aerated waters; in addition to these anions, sulfide is important in anoxic, sulfate-rich waters. (See also W88-01198) (Lantz-PTT)
W88-01199

ENVIRONMENTAL TRANSPORT,
Midwest Research Inst., Kansas City, MO.
B. L. Carson.
IN: Trace Metals in the Environment: Volume 6 - Cobalt, An Appraisal of Environmental Exposure. Ann Arbor Science Publishers Inc., Ann Arbor, MI. 1981. p 531-662, 5 fig, 37 tab, 243 ref.

Descriptors: *Heavy metals, *Path of pollutants, *Cobalt, *Soil contamination, *Groundwater movement, Soil chemistry, Sediments, Clay, Hydrogen ion concentration, Soil water, Chemical analysis, Fate of pollutants, Chemical reactions.

Cobalt is held to a greater degree by soils with higher pH and higher contents of clay, natural organics, and hydrous manganese and iron oxides. Very strong organic-complexing agents, such as EDTA--which is now a widespread contaminant of U.S. waters--greatly enhance cobalt mobility. Weaker organic-complexing agents, such as those present in plant extracts, also increase its extractability. Formation of either weak or strong soluble organic complexes of cobalt decreases its uptake by plants. Many factors complicate the transport and speciation of cobalt in natural waters and sediments, and few generalities can be made. Anthropogenic pollution appears to enhance the solubility of cobalt in freshwater by complexing it with sewage-derived organics. Predominant cobalt species in unpolluted freshwater are: Co(2+), the carbonate, the hydroxide, the sulfate, adsorbed forms, oxide coatings, and crystalline sediments; in seawater: CoCl(+), Co(2+), the carbonate, and the sulfate. Cobalt transport in soils and water are discussed and atmospheric emissions of cobalt are described. Atmospheric transport of cobalt has not been nearly so well studied as its behavior in soils and water. The descriptions of atmospheric emissions and related environmental contamination are, however, necessary preliminaries to understanding the behavior of aerosol cobalt. (See also W88-01198) (Lantz-PTT)
W88-01200

COBALT IN THE FOOD CHAIN,
Midwest Research Inst., Kansas City, MO.
C. J. Cole, and B. L. Carson.
IN: Trace Metals in the Environment: Volume 6 - Cobalt, An Appraisal of Environmental Exposure. Ann Arbor Science Publishers Inc., Ann Arbor, MI. 1981. p 777-924, 1 fig, 28 tab, 297 ref.

Descriptors: *Path of pollutants, *Heavy metals, *Cobalt, *Food chains, Aquatic environment, Fate of pollutants, Trophic level, Ecosystem.

Information on cobalt in the aquatic food chain, in the terrestrial food chain, and in the human diet and human tissues is summarized. Difficulties in calculating a human body burden are discussed. In general, cobalt concentration factors diminish with increasing trophic levels in any particular food chain. Exceptions are noted in a predator-herbivore-plant-soil chain in a temperature ecosystem and in a reptile/amphibian-insect-plant-soil chain in a tropical moist forest. In contaminated or heavily cobalt-fertilized media, the concentration factors for plants do not increase as rapidly as do the media concentrations. (See also W88-01198) (Lantz-PTT)
W88-01201

NATURAL ACIDITY OF WATERS IN PODZOLIZED SOILS AND POTENTIAL IMPACTS FROM ACID PRECIPITATION,
Colorado State Univ., Fort Collins. Dept. of Earth Resources.
J. D. Stednick, and D. W. Johnson.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 299-302, 2 tab, 10 ref. DOE Contract No. RP-1813-1.

Descriptors: *Hydrometeorology, *Acidity, *Path of pollutants, *Acid rain, *Chemical reactions, *Podzols, *Environmental effects, *Alaska, Nutrients, Soil water, Hydrogen ion concentration, Acidic soils, Organic acids, Color, Iron.

Nutrient movements through sites in southeast Alaska and Washington were documented to determine net changes in chemical composition of precipitation water as it passed through a forest soil and became stream flow. These sites were not subject to acid precipitation (rainfall pH 5.8-7.2), yet soil water was acidified to 4.2 by natural organic acid forming processes in the podzol soils. Organic acids precipitated in the subsoils, allowing a pH increase. Stream water pH ranged from 6.5 to 7.2 indicating a natural buffering capacity that may exceed any additional acid input from acid rain. Precipitation composition was dominated by magnesium, sodium, and chloride due to the proximity of the ocean at the southeast Alaska site. Anionic constituents of the precipitation were dominated by bicarbonate at the Washington site. Soil podzolization processes concurrently increased solution color and iron concentrations in the litter and surface horizons leachates. The anion flux through the soil profile was dominated by chloride and sulfate at the southeast Alaska site, whereas at the Washington site anion flux appeared to be dominated by organic acids. Electroneutrality calculations indicated a cation deficit for the southeast Alaska site. (See also W88-01203) (Author's abstract)
W88-01250

U.S. NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM,
National Acid Precipitation Assessment Program, Washington, DC.
For primary bibliographic entry see Field 5C.
W88-01273

GAS PHASE AND PRECIPITATION ACIDITIES IN THE COLORADO MOUNTAINS,
Colorado Coll., Colorado Springs.
B. J. Huebert, R. B. Norton, M. J. Bollinger, D. D. Parrish, and C. Hahn.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 443-449, 7 fig, 19 ref.

Descriptors: *Hydrometeorology, *Chemistry of precipitation, *Chemical reactions, *Acid rain, *Colorado, *Water pollution sources, Nitric acid, Nitrates, Aerosols, Chemical analysis, Ion chromatography, Hydrogen ion concentration, Conductivity, Path of pollutants, Snow.

For the past few years, both the gas phase concentrations of nitric acid, its precursors, and nitrate aerosols and the precipitation concentrations of nitrate were measured at Niwot Ridge, a remote area field site located at 3 km elevation in the Colorado mountains west of the Denver metropolitan area. The measurements were made using a variety of techniques: filter collection, ion chromatographic analysis, direct pH and conductivity determinations, and chemiluminescence detection. An extensive wind speed/ wind direction network, coupled with trajectory analyses, provided meteorological support. The prevailing winds at the site are from the west, although occasionally the wind is from the east, across the metropolitan area in that direction. Correlations between the wind direction and the acidity levels, both in the air and in the preparation, show that, despite the fact that east winds are atypical, the acidic components accompanying these winds are the likely major source of the relatively high acid deposition that occurs at the site. The observed nitric acid/precursors correlations are consistent with the current picture of the transformation chemistry. During the winter of 1980/81, it was shown that snow scavenges nitric acid and nitrate very efficiently. (See also W88-01203) (Author's abstract)
W88-01274

SPATIAL AND TEMPORAL TRENDS IN THE CHEMISTRY OF ATMOSPHERIC DEPOSITION IN NEW ENGLAND,
Maine Univ. at Orono. Dept. of Geological Sciences.
D. W. Hanson, and S. A. Norton.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 451-459, 11 fig, 12 ref. NSF Grant No. DEB-78-10641.

Descriptors: *Hydrometeorology, *Chemistry of precipitation, *Spatial distribution, *Temporal distribution, *Acid rain, *New England, *Chemical reactions, *Path of pollutants, *Quebec, Soil chemistry, Hydrogen ion concentration, Lakes, Manganese, Calcium, Magnesium, Potassium, Zinc, Iron, Lead, Copper, Aluminum, Chemical analysis, Heavy metals, Air pollution.

Atmospheric deposition related geochemical changes in New England and Quebec were evaluated by means of (1) transect studies of soil chemistry parallel to pH and metal deposition gradients; and (2) chemical analysis of lake sediments with the following results: (a) Mn, Ca, Mg, K, Zn, Fe, and Pb concentrations and pH in organic litter of high altitude spruce-fir forests relate to the present pH gradients for precipitation and inferred gradients of heavy metal loading; (b) atmospheric deposition of heavy metals (including Pb, Zn, and Cu) began increasing in the 19th century in New England and may be leveling out in the last 5-10 years. Accelerated mechanical erosion may mask increases in concentration of these elements in lake sediments but deposition rate calculations indicate as much as a 12X increase in sediment accumulation rate of Pb due to atmospheric loading. Relative increases depend on increased loading, background values, and total deposition rate. Inferred acidification of precipitation and surface waters has resulted in increased leaching of Zn, Ca, Mg, and Al from soils and sediments with inferred concurrent increases in concentrations of these elements in surface waters. Results (a) and (b) imply that increasing atmospheric deposition of acids and metals has strongly influenced forest soils, sediment, and surface water chemistry. (See also W88-01203) (Author's abstract)
W88-01275

RAPID FLUCTUATIONS IN STREAMFLOW PH AND ASSOCIATED WATER QUALITY PARAMETERS DURING A STORMFLOW EVENT,
Northeastern Forest Experiment Station, University Park, PA.
E. S. Corbett, and J. A. Lynch.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 461-464, 2 tab, 14 ref.

Descriptors: *Hydrometeorology, *Hydrogen ion concentration, *Chemical reactions, *Water quality, *Storms, *Acid rain, *Fate of pollutants, *Pennsylvania, Streamflow, Path of pollutants, Hydrographs, Rainfall, Acidity, Alkalinity.

Three aspects of hydrometeorological significance - the quality of precipitation, the watershed response of converting precipitation into streamflow, and the resulting change in streamflow quality - were studied on a forested experimental watershed in central Pennsylvania. Changes in streamflow quality over time due to a 4.38-inch rainstorm are discussed. Hydrograph analysis indicated 23.6% of the rainfall input was discharged as stormflow. Streamflow pH declined from 7.32 to 4.95 during the storm, and H(+) concentration increased over 200 times. Alkalinity decreased from 480 to 20 microequivalents/L, while acidity increased from -328 to 220 microequivalents/L during the stormflow period. Seven days after rainfall ended and during which time no additional rain occurred, alkalinity had only recovered to 73 microequivalents/L. (See also W88-01203) (Author's abstract)
W88-01276

ACID PRECIPITATION AND BUFFER CAPACITY OF LAKES IN THE SIERRA NEVADA, CALIFORNIA,
California Univ., Santa Barbara. Dept. of Biological Sciences.
J. M. Melack, J. L. Stoddard, and D. R. Dawson.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 465-471, 3 fig, 2 tab, 27 ref. OWRT Project No. A-080-CAL and WRCP Project No. UCAL-WRC-590.

Descriptors: *Hydrometeorology, *Acid rain, *Chemical reactions, *Lakes, *California, *Sierra Nevada, *Fate of pollutants, Sulfuric acid, Nitric acid, Hydrogen ion concentration, Chemical analysis, Alkalinity.

The east central Sierra Nevada received acid precipitation (pH 3.7 to 4.9) during convective storms interspersed through the dry season of 1981. Sulfuric acid contributed about twice the acidity of nitric acid. In contrast, late autumn, winter, and early spring snow (1981-1982) ranged in pH from 5.2 to 6.1 (means 5.7) and had low ammonium, nitrate, and sulfate concentrations. As of 1981 most of the alpine lakes of the Sierra Nevada remain very weakly buffered, bicarbonate lakes that receive a small loading of acid precipitation and a large annual input of snowmelt uncontaminated by strong acids. If the acidity of the precipitation increases, the pH of the lakes will decrease rapidly because the lakes and their basins have extremely low buffer capacity especially when runoff peaks during snow melt. (See also W88-01203) (Author's abstract)
W88-01277

IMPACT OF THE RESOURCE CONSERVATION AND RECOVERY ACT ON THE DESIGN OF HAZARDOUS WASTE INCINERATORS,
IT Enviroscience, Inc., Knoxville, TN.
For primary bibliographic entry see Field 6E.
W88-01301

KINETICS MODEL AND SIMULATION OF CONCENTRATION VARIATIONS OF SPECIES OF POLYCHLORINATED BIPHENYLS INVOLVED IN PHOTOCHEMICAL TRANSFORMATION,
Tennessee Univ., Knoxville. Dept. of Engineering Science and Mechanics.
E. V. Kalmaz, R. B. Craig, and G. W. Zimmerman.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 233-240, 3 fig, 12 ref.

Descriptors: *Kinetics, *Model studies, *Polychlorinated biphenyls, *Detoxification, *Fate of pollutants, *Photochemistry, *Path of pollutants, *Chemical reactions, Water pollution sources, Air pollution, Chlorodibenzofuran.

Polychlorinated biphenyls (PCB) are potentially toxic and carcinogenic compounds whose large-scale use over the years has made them ubiquitous in the environment. A recent study by the National Academy of Sciences indicates that total U.S. PCB use as of 1976 was 6.1 times 10 to the 8th power kg. The Atlantic Ocean appears to be a major sink for PCB, accounting for 80% of the PCB burden in the environment. Many freshwater lakes and rivers also serve as sinks for PCB. Atmospheric transport plays a major role in the worldwide dissemination of PCB. Most of the transport of PCB to the North Atlantic is thought to be atmospheric. PCB transport to freshwaters, such as Lake Michigan, is also thought to have an important atmospheric component. PCB released directly into the atmosphere adsorb onto particulates and are transported with the prevailing winds. Creation of free radicals by sunlight allows environmental replacement of chlorines by hydroxy groups from water without the intervention of alkali when this occurs at the ortho position (found to be the most preferred for chlorine loss). The resulting 1-hydroxychlorobiphenyl is perfectly positioned to allow oxygen to bond an ortho position on the other ring. This results in formation of the potentially most important class of contaminant in PCB mixtures: the highly toxic chloridibenzofurans. The photochemical kinetics model was developed to predict the change in concentrations and formation of predominant PCB under the influence of sunlight in a microsurface layer of aquatic environments. The rate constants of the photochemical reactions and initial concentrations of each chemical species are considered in the kinetic model. The computer code uses the reaction rate constants, average surface temperature and pH of the complex photochemical reactions in surface waters. The kinetics model incorporates the most important photochemical reactions that are known to occur when PCB are discharged into the aquatic environment over relatively long periods of time. (See also W88-01297) (Lantz-PTI)
W88-01310

CHLORODIBENZODIOXINS AND CHLORODIBENZOFURANS: AN OVERVIEW,
Wright State Univ., Dayton, OH. Brehm Lab.
T. O. Tiernan.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 243-260, 4 fig, 11 tab, 11 ref.

Descriptors: *Detoxification, *Hazardous wastes, *Toxic wastes, *Chlorodibenzodioxins, *Chlorodibenzofurans, *Fate of pollutants, *Chlorinated hydrocarbon, *Environmental effects, Water pollution sources, Path of pollutants, Organic solvents, Water pollution effects.

Widespread concern has arisen with respect to contamination of the environment by chlorodibenzodioxins (CDD) and chlorodibenzofurans (CDF). This concern has been prompted in part by observations, principally based on animal studies, that indicate that certain of the CDD and CDF exhibit potent toxicity. In addition, it has been recognized that, since the CDD and CDF are present as contaminants in numerous commercial chemicals that have been or are being produced and used in large quantities, the potential for extensive environmental contamination by these compounds is very great. Moreover, CDD and CDF generally are quite stable, chemically and thermally, and are

reasonably soluble in several common organic solvents. There is some evidence to suggest that the CDD and CDF are accumulating in the environment, and that these compounds persist for considerable periods. A concise overview of the present status of knowledge of the CDD and CDF is given, as a prelude to discussions of various methods of destroying these compounds or detoxifying wastes in which they are contained. (See also W88-01297) (Lantz-PTT)
W88-01311

FIELD TEST FOR EFFECTIVE POROSITY AND DISPERSIVITY IN FRACTURED DOLOMITE, THE WIPP, SOUTHEASTERN NEW MEXICO,
Sandia National Labs., Albuquerque, NM.
D. D. Gonzalez, and H. W. Bentley.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 207-221, 6 fig, 3 tab, 7 ref.

Descriptors: *Radioactive wastes, *Waste disposal, *Path of pollutants, *Tracers, *Dolomite, *Hydraulic properties, *Groundwater movement, New Mexico, Aquifers, Solute transport, Field tests, Transmissivity, Porosity, Dispersivity, Soil physical properties, Soil properties, Anions, Model studies, Prediction.

The Waste Isolation Pilot Plant (WIPP), a demonstration facility in New Mexico, which is used to store transuranic waste in Permian-bedded salts has been under field investigation since 1975. Previous hydrogeologic investigations showed a fractured dolomite as the most likely groundwater vehicle to transport waste to the biosphere in the event such a repository is breached. In order to describe and predict solute transport, hydraulic characteristics including the difficult to predict parameters of effective porosity and dispersivity, of the transporting medium needed to be estimated along a hypothetical flow path. Two-well recirculation tracing tests were performed. As a result of tests for tracer performance and simplicity in handling and analysis, the anions pentafluorobenzoate and sodium thiocyanate were chosen as tracers for use in evaluating the aquifer parameters in dolomites at the WIPP. Porosity and dispersivity at the H-2 site were estimated at 18% and 5.2 m, respectively. The data obtained from the recirculating tests were valuable in establishing the flow and solute transport regime in the Culebra Dolomite of the Rustler Formation in the vicinity of the H-2 location. The type curves generated by the Grove-Beetem model fit the early portions of the data, but did not match late-time data. The model cannot match the decline in concentrations without modification to include anisotropy, variable pumping rates and boundary conditions, and solute retardation in terms of matrix probability. A site specific numerical model was indicated that used both recirculation and convergent flow tracer test for calibration. (See also W88-01344) (Wood-PTT)
W88-01352

FORMULATION OF MODELS BASED ON THE AVERAGE CHARACTERISTICS OF A HETEROGENEOUS AQUIFER,
Florida Univ., Gainesville.
H. Rubin, and B. A. Christensen.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 344-367, 4 fig, 18 ref.

Descriptors: *Saline water intrusion, *Path of pollutants, *Mathematical models, *Model studies, *Aquifers, *Solute transport, *Groundwater movement, Groundwater, Data interpretation, Mathematical studies, Florida, Mathematical equations, Computers, Simulation.

A general methodology was developed for the formulation of the mathematical models concerning transport processes in aquifers. Simplified models with reduced requirements for computer time are needed to replace previous approaches used for flow field simulation. Generally, variable characteristics of the aquifer lead to nonlinearities in the mathematical models used for the simulation of transport processes. In such cases, numerical calculations, which are subject to convergence and stability limitations, usually required large quantities of computer time and memory. Application of the method of the aquifer's average characteristics which involve replacement of the basic equations representing transport phenomena that depend on local characteristics of a porous medium with equations considering the average characteristics of the aquifer simplified the mathematical models. Appropriate mathematical equations and some derivations are presented. (See also W88-01344) (Wood-PTT)
W88-01359

GALERKIN-FINITE ELEMENT TWO-DIMENSIONAL TRANSPORT MODEL OF GROUNDWATER RESTORATION FOR THE IN SITU SOLUTION MINING OF URANIUM,
Colorado State Univ., Fort Collins.
J. W. Warner, and D. K. Sunada.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 368-391, 7 fig, 12 ref.

Descriptors: *Water pollution treatment, *Land reclamation, *Mine-site restoration, *Path of pollutants, *Model studies, *Solute transport, *Groundwater pollution, *Groundwater movement, *Uranium mining, Groundwater, In situ mining, Groundwater management, Cation exchange, Ion exchange, Colorado, Mathematical equations, Mathematical studies.

In situ mining represents a new, more complex contaminant transport problem in site restoration than traditional contaminant transport problems. The simulation of groundwater site restoration of contaminants subject to adsorption and desorption on the solid aquifer material requires a greater sophistication then previous transport models because of the complex chemistry involved. A solute transport model was developed that is capable of simulating binary cation exchange between two reacting solutes. The model was applied to an actual problem of groundwater restoration for a pilot-scale uranium solution mining operation in northeast Colorado. In situ uranium solution mining involves injection of a lixiviant consisting of a leaching chemical and an oxidizing agent through wells into the sandstone formation which contains the uranium deposits. The uranium ore is preferentially dissolved from the host rock and the uranium-bearing groundwater is recovered through pumping wells. After mining, restoration of the contaminated groundwater is required. The developed model is presented as a basic working tool to be used by regulatory agencies, mining companies, and others concerned with groundwater restoration for prediction and for evaluation of alternative restoration strategies. (See also W88-01344) (Wood-PTT)
W88-01360

MANAGEMENT OF TOXIC SUBSTANCES IN OUR ECOSYSTEMS: TAMING THE MEDUSA.
Ann Arbor Science, Ann Arbor, MI. 1981. 186 p. Edited by Barney W. Cornaby.

Descriptors: *Toxic wastes, *Hazardous wastes, *Hazardous materials, *Pollutants, *Water pollution, Water pollution control, Human diseases, Public health, Path of pollutants, Pollutant identification, Heavy metals, Combined pollutants, Bioassays.

Papers given at the symposium 'Taming of the Medusa: Toxic Substances in Our Ecosystems' held in 1980 are presented. The different but interrelated perspectives on the toxic substance problem, human populations and ecosystems, are discussed in two papers dealing with epidemiological studies and extrapolation from animal toxicity and chemical data to the intervention of human cancer patterns and the hierarchical and biogeochemical cycles approach to measuring toxic effect to ecosystems at the system, not the component, level. Papers on synergistic and antagonistic effects of chemical mixtures, protocols of biological tests for documenting effects of emissions, and the management strategies for controlling certain substances are also given. Together the symposium papers provide a logical series that explains how toxic substances are being or can be managed in our ecosystems. (See W88-01363 thru W88-01368) (Wood-PTT)
W88-01362

TOXIC SUBSTANCES: CLEAR SCIENCE, FOGGY POLITICS,
Marine Biological Lab., Woods Hole, MA. Ecosystems Center.
G. M. Woodwell.
IN: Management of Toxic Substances in Our Ecosystems: Taming the Medusa. Ann Arbor Science, Ann Arbor, MI. 1981. p 5-17, 5 ref.

Descriptors: *Toxic wastes, *Hazardous wastes, *Path of pollutants, *Pollutants, *Water pollution sources, *Water pollution control, Political aspects, Hazardous materials, Toxicity, Economic aspects, Pesticides, Radioactivity, DDT.

The problems of controlling the manufacture and use of toxic substances embody nearly all the elements of the contemporary crisis of environment: growth, profits, and economic and political power. Experiences with two groups of toxic substances, ionizing radiation and pesticides, are summarized. Ionizing radiation is an example of an inadvertant waste product of technology that happens to have powerful biotic effects. Pesticides, in contrast, are produced and used because of their biotic effects. Evidence is presented to show that toxics, such as radioactive debris or any substance that can be vaporized or distributed as small airborne particles, that have a residence time in the atmosphere of hours to days can be carried worldwide by atmospheric transport. Insecticidal properties, persistence and distribution of DDT are reviewed. While it is desirable for a pesticide to retain its effectiveness, the longer it does so, the greater the probability that its residues will migrate and accumulate in places where they present a hazard to humans and other organisms. It is concluded that there is no alternative to the development of closed systems for management of toxics and that increased original research in this area is required. (See also W88-01362) (Wood-PTT)
W88-01363

PARADIGMS IN MULTIPLE TOXICITY,
Concordia Univ., Sir George Williams Campus, Montreal (Quebec). Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W88-01366

TOWARD IMPROVED CONTROL OF TOXIC SUBSTANCES,
Monsanto Research Corp., Dayton, OH.
G. D. Rawlings.
IN: Management of Toxic Substances in Our Ecosystems: Taming the Medusa. Ann Arbor Science, Ann Arbor, MI. 1981. p 121-144, 3 fig, 6 tab, 13 ref.

Descriptors: *Toxic wastes, *Hazardous wastes, *Toxicity, *Industrial wastewater, *Water pollution sources, *Water pollution control, *Textile mill wastes, Wastewater, Pollutants, Pollutant identification, Effluents, Sampling, Testing procedures, Organic compounds, Biological properties, Chemical properties.

After the need to manage potentially toxic effluents was mandated by legislation, large programs were launched to evaluate the toxicity of textile plant wastewaters and to determine the most effective treatment technology. The overall Environmental Protection Agency textile program consisted of two separate projects with the same goal of determining the 'best available technology economically available'. Field sampling and analytical methods are detailed and the results from the GC/MS analyses of samples from 64 textile plant raw waste and secondary effluents for organic priority pollutants are summarized. The results of chemical analyses to identify the classes of com-

pounds present in environmental samples and to measure the general concentration range indicated the presence of aliphatic hydrocarbons, aromatic compounds, esters, fatty acid groups and phthalate esters. The results of biological tests on secondary wastewater samples for assessment of both health and ecological effects are presented. Although the preliminary results obtained in this study will need to be confirmed, they will be used to guide plans for the management of toxic substances in ecosystems. (See also W88-01362) (Wood-PTT)
W88-01368

BIODEGRADATION AND DETOXIFICATION OF ENVIRONMENTAL POLLUTANTS.
CRC Press, Inc., Boca Raton, FL. 1982. 147 p. Edited by A. M. Chakrabarty.

Descriptors: *Toxic wastes, *Fate of pollutants, *Microbial degradation, *Biodegradation, *Detoxification, *Hydrocarbons, Enzymes, Pesticides, Metabolism, Pollutants, Polychlorinated biphenyls, Aromatic compounds, Microorganisms, Bacteria, Mercury, Genetics.

Recent advances in understanding the biological mechanisms in the biodegradation and detoxification of various environmental pollutants are reviewed. The enzymes involved in the hydroxylation and detoxification of many carcinogenic polycyclic aromatic hydrocarbons by various mammalian tissues were studied, and the genetic basis of such hydroxylation delineated. The toxicological problems created by persistent halogenated hydrocarbons focused attention on the desirability of a detailed study of the biodegradability of such compounds in the environment. Progress in understanding the enzymatic breakdown of various chlorinated molecules and pesticides both by aerobic and anaerobic microorganisms is reported. Extra chromasomal genetic elements that are known to be involved in the biodegradation of various chlorinated and nonchlorinated hydrocarbons are described. Detailed enzymatic and genetic mechanisms involving reduction or methylation of mercury and its derivatives are discussed and reviews of recent studies on the mode of detoxification of such mercurial compounds by various microorganisms are presented. (See W88-01370 thru W88-01374) (Author's abstract)
W88-01369

MICROBIAL METABOLISM AND ENZYMOLOGY OF SELECTED PESTICIDES,
Oklahoma Univ., Norman. Dept. of Botany and Microbiology.
D. M. Munnecke, L. M. Johnson, H. W. Talbot, and S. Barik.
IN: Biodegradation and Detoxification of Environmental Pollutants. CRC Press, Inc., Boca Raton, FL. 1982. p 1-32, 2 fig, 2 tab, 132 ref, append.

Descriptors: *Toxic wastes, *Pesticides, *Detoxification, *Pesticides, *Microbial degradation, *Fate of pollutants, *Path of pollutants, *Metabolism, *Toxicity, Organophosphorus pesticides, Phosphothioate pesticides, Carbamate pesticides, Phenylurea pesticides, Acylanilide pesticides, Phenoxyacetate pesticides, Enzymology, Pollutants, Enzymes, Hydrolysis.

The scientific literature pertaining to the metabolism of various pesticides by cell-free enzyme extracts are reviewed in order to show the potential that microbial enzyme systems have for the detoxification and disposal of pesticides in industrial situations. It was postulated that microbial enzymes could be isolated and be effective in the conversion of toxic or persistent pesticides into less toxic or persistent molecules. For pesticides belonging to the organophosphates, dithioates, carbamates, acylanilides, phenylureas, and phenoxyacetates, hydrolases which are generally stable enzymes that do not require co-factors are instrumental in initial steps of whole cell metabolism. A table listing the toxicity of some selected pesticides and the toxicity of the major enzymatic hydrolysis product is presented showing that for organophosphates, dithioates, and carbamates, a hydrolysis of the parent pesticide generally leads to a significant reduction in toxicity. For acylanilides, phenylureas, and phenoxyacetates, hydrolysis does not lead to a significant reduction in toxicity or, in some cases, produces more toxic chemicals though the biospecificity of the pesticide molecule is destroyed and the metabolites are not as environmentally stable as the parent pesticide. The enzymology of pesticide metabolism is detailed for each of the six previously mentioned classes of pesticides and potential industrial applications are discussed. (See also W88-01369) (Wood-PTT)
W88-01370

MICROBIAL DEGRADATION OF POLYCHLORINATED BIPHENYLS (PCBS),
Fermentation Research Inst., Yatabe (Japan).
K. Furukawa.
IN: Biodegradation and Detoxification of Environmental Pollutants. CRC Press, Inc., Boca Raton, FL. 1982. p 33-57, 7 fig, 3 tab, 185 ref.

Descriptors: *Toxic wastes, *Detoxification, *Polychlorinated biphenyls, *Microbial degradation, *Fate of pollutants, *Environmental effects, *Path of pollutants, *Biodegradation, *Literature review, Toxicity, Pollutants.

The interaction between polychlorinated biphenyls (PCBs) and microorganisms is reviewed mainly from the viewpoint of PCB biodegradation. The behavior of PCBs in the ecosystem is discussed with emphasis on the transfer of PCBs into the environment, magnification of PCB concentration in the environment, and the toxic effect of PCBs in the ecosystem. Results of previous experiments investigating the bacterial degradation of PCBs and the effects of chlorine substitution on biodegradability of PCBs are reviewed. Bacterial metabolism studies with 36 pure isomers of PCBs demonstrated that 23 compounds were metabolized by an Alcaligenes sp., and that 33 compounds were metabolized by an Acinetobacter sp.; a summary of previous conclusions regarding metabolic patterns is presented. The fate of PCBs in the environment is discussed. (See also W88-01369) (Wood-PTT)
W88-01371

CHEMICAL TRANSFORMATIONS OF AROMATIC HYDROCARBONS THAT SUPPORT THE GROWTH OF MICROORGANISMS,
University Coll. of North Wales, Bangor. Dept. of Biochemistry and Soil Science.
D. W. Ribbons, and R. W. Eaton.
IN: Biodegradation and Detoxification of Environmental Pollutants. CRC Press, Inc., Boca Raton, FL. 1982. p 59-84, 12 fig, 151 ref.

Descriptors: *Toxic wastes, *Detoxification, *Hydrocarbons, *Aromatic compounds, *Microbiological studies, *Chemical reactions, *Fate of pollutants, *Microorganisms, *Literature review, Bacteria, Benzenes, Alkylbenzenes, Microorganism growth, Growth.

Microorganisms have been observed to use aromatic hydrocarbons as nutrients for assimilation. The review, which reduced the large number of reports on the microbial transformations of aromatic hydrocarbons into generalized catabolic pathways, includes sections on the microbial utilization of benzene, monoalkyl benzenes, dialkyl benzenes, and fused polynuclear hydrocarbons. The evidence for most of the illustrated pathways came from many isolated observations with different bacterial strains. Only pathways elaborated in microorganisms able to grow with aromatic hydrocarbons as carbon and energy source are discussed which restricted the biological scope of the review to bacteria. The major catabolic routes to amphibolic intermediates and some minor alternative transformations that may lead to dead-end products are included. Appropriate diagrams of the catabolic routes are presented. (See also W88-01369) (Wood-PTT)
W88-01372

GENETIC AND BIOCHEMICAL BASIS FOR MICROBIAL TRANSFORMATIONS AND DETOXIFICATION OF MERCURY AND MERCURIAL COMPOUNDS,
Washington Univ., St. Louis, MO. Dept. of Biology.
S. Silver, and T. G. Kinscherf.
IN: Biodegradation and Detoxification of Environmental Pollutants. CRC Press, Inc., Boca Raton, FL. 1982. p 85-103, 5 fig, 101 ref.

Descriptors: *Toxic wastes, *Heavy metals, *Mercury, *Organomercury compounds, *Microbial degradation, *Microbial transformation, *Fate of pollutants, *Genetics, *Biochemistry, *Literature review, *Detoxification, Bacteria, Methylation, Microbial resistance, Genes, Pollutants.

Because mercury and organomercurial compounds are natural components of the ecosphere, the bacterial transformation of these compounds exists in the absence of any human involvement although human activities have influenced the local distribution and balances of the element. The review, which sketches an overall picture of the mercury cycle in the biosphere, emphasizes the role of microbial systems in this cycle and presents the facts known about the genetic and biochemical bases for the microbial transformations. Microbial transformations of mercury including methylation and detoxification are described and diagrammed. Microbial resistance to mercury and organomercurials is described and the inducibility of mercury resistance and transposability of the genes determining mercury resistance are detailed. (See also W88-01369) (Wood-PTT)
W88-01373

GENETIC MECHANISMS IN THE DISSIMILATION OF CHLORINATED COMPOUNDS,
Illinois Univ. at the Medical Center, Chicago.
A. M. Chakrabarty.
IN: Biodegradation and Detoxification of Environmental Pollutants. CRC Press, Inc., Boca Raton, FL. 1982. p 127-139, 3 fig, 3 tab, 47 ref.

Descriptors: *Toxic wastes, *Chlorinated hydrocarbons, *Genetics, *Dissimilation, *Fate of pollutants, *Plasmids, *Microbial degradation, *Detoxification, Biodegradation, Hydrocarbons, Bacteria, Enterobacter, Enzymes, Evolution, Pollutants.

Some aspects of microbial dissimilation of chlorinated compounds, with particular emphasis on the role of plasmids in such processes, and genetic mechanisms governing dissimilation of chlorinated compounds by members of Enterobacteriaceae are reviewed. The specificity and evolution of new enzymes in the biodegradation of chlorinated compounds is discussed. The evolution of new sets of enzymes that can act specifically on chlorinated compounds as substrates, but not or only slowly on the nonchlorinated parent compounds, is important since it raised the question of how microorganisms evolve new enzymatic functions and how such evolution processes can be accelerated for enhanced biodegradation of various pollutants. A list of plasmids on which the genes specifying biodegradation of a number of chlorinated and nonchlorinated hydrocarbons are borne is given. The expression of hydrocarbon degradative genes in enteric and other bacteria and the evolution of new metabolic competence for hydrocarbon oxidation in the family enterobacteriaceae are discussed. It is thought that an understanding of the genetic mechanisms of dissimilation of chlorinated compounds, including limitations on biochemical processes and genetic expression, will be valuable in constructing appropriate strains for enhanced biodegradation and ultimate removal of various synthetic pollutants from the environment. (See also W88-01369) (Wood-PTT)
W88-01374

LESSON OF LOVE CANAL,
New York State Dept. of Health, Albany. Div. of Labs. and Research.
For primary bibliographic entry see Field 5C.
W88-01376

ASSESSING THE PROBLEM -- LOVE CANAL,
Roswell Park Memorial Inst., Buffalo, NY. Dept. of Molecular Biology.
For primary bibliographic entry see Field 5C.

W88-01377

TECKOMATORP, SWEDEN -- WASTE PROBLEMS FROM THE PERSPECTIVE OF A MANUFACTURING INDUSTRY,
National Swedish Environment Protection Board, Solna.
R. Ferm.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 31-36, 2 fig.

Descriptors: *Waste disposal, *Hazardous wastes, *Waste management, *Water pollution control, *Sweden, *Path of pollutants, *Groundwater pollution, Leaching, Toxins, Organic compounds, Soil contamination, Wastewater treatment, Solid waste disposal, Industrial wastes, Activated carbon, Phenols.

Following complaints about raw water quality by greenhouse owners downstream from a Swedish company located in Teckomatorp, the Environment Protection Board persuaded the company to voluntarily apply for a permit. The company denied discharging pollutants into the stream, but after drums buried onsite were analyzed for their contents, and were found to contain high amounts of phenoxy acids as well as chlorophenols, it was concluded that company officials had falsified information for purposes of obtaining the permit. The Environment Protection Board and The County Administration demanded a re-trial by the permit board and consulted another company to suggest suitable countermeasures to guard against further pollution of the soil and groundwater. A collection ditch was constructed to surround the company and store water for purification using an activated carbon filter. In 1977 the company changed the production process to omit chemical reactions and to carry out only mixing and packaging of products. A later analysis of the discharge water showed that the activated carbon treatment was not operating in an acceptable way. The factory was closed by order of the Swedish Government in October 1977. (See also W88-01375) (Geiger-PTT)
W88-01378

TECKOMATORP, SWEDEN -- WASTE PROBLEMS FROM THE PERSPECTIVE OF A MANUFACTURING INDUSTRY,
Skane County Environmental Office, Malmo (Sweden).
For primary bibliographic entry see Field 5G.
W88-01379

ASSESSMENT OF THE CHURCH ROCK URANIUM MILL TAILINGS SPILL: A STRATEGY FOR EVALUATING HEALTH RISKS FROM NUCLEAR FUEL CYCLE ACCIDENTS,
Centers for Disease Control, Atlanta, GA.
For primary bibliographic entry see Field 5C.
W88-01380

LATHROP, CALIFORNIA: ASSESSING THE PROBLEM,
California Dept. of Health Services, Berkeley. Hazardous Materials Lab. Section.
For primary bibliographic entry see Field 5C.
W88-01381

LOVE CANAL: ENVIRONMENTAL STUDIES,
New York State Dept. of Health, Albany. Div. of Labs. and Research.
C. S. Kim, R. Narang, A. Richards, K. Aldous, and P. O'Keefe.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 77-94, 8 fig, 2 tab, 8 ref.

Descriptors: *Solid waste disposal, *Landfills, *Path of pollutants, *Soil contamination, *Groundwater pollution, Environmental effects, Hazardous materials, Cleanup, Chlorinated hydrocarbons, Public health, Monitoring.

Extensive chemical analyses have shown that the contamination at the Love Canal landfill is consistent with the documented classes of chemical wastes buried by Hooker Chemical Company and it includes significant concentrations of 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCDD). Evidence of through-ground transport of chemical wastes appears limited to the first ring of homes, except along the permeable fill around utility lines under Frontier Avenue. Migration of wastes from the canal has occurred by storm sewer and by use of Love Canal soils as fill in residential development. All future land development should be preceded by a thorough understanding of prior land use - especially when choosing sites for schools. (See also W88-01375) (Geiger-PTT)
W88-01383

SALSBURY LABORATORIES - LA BOUNTY SITE: A PHASED APPROACH TO A HAZARDOUS WASTE DISPOSAL PROBLEM,
National Enforcement Investigations Center, Denver, CO.
For primary bibliographic entry see Field 5G.
W88-01384

REPORT ON CMA'S INVESTIGATION OF THE LIPARI LANDFILL,
Chemical Manufacturers Association, Washington, DC.
For primary bibliographic entry see Field 5C.
W88-01385

REMEDIAL SITE CONTAINMENT,
Conestoga-Rovers and Associates, Waterloo (Ontario).
For primary bibliographic entry see Field 5G.
W88-01395

POLICY, LEGAL AND TECHNICAL MEASURES TO COMBAT POLLUTION OF SOIL AND GROUND WATER FROM NON-POINT SOURCES,
For primary bibliographic entry see Field 5G.
W88-01404

MAIN PRINCIPLES OF THE METHODS IN DEFINING THE ECONOMIC EFFICIENCY OF MEASURES FOR PRESERVING UNDERGROUND WATERS FROM NITRATE POLLUTION AT FERTILIZATION,
A. Tannov, M. Fzoneva, I. Frankov, and E. Kabakchieva.
United Nations, Economic Commission for Europe, WATER/SEM.14/R.11, March 9, 1987. 9 p.

Descriptors: *Nitrogen removal, *Water pollution control, *Water pollution sources, *Groundwater pollution, *Nitrates, Water pollution prevention, Water quality management, Agricultural runoff, Fertilizers, Fate of pollutants, Drinking water, Economic aspects, Crop yield, Crop production.

During the last several years nitrate concentration exceeding the admissible norm for drinking water has been observed in some groundwater sources in the P. R. of Bulgaria. Two ways of lessening groundwater pollution with nitrates of mineral origin are prevention of pollutant transport through a number of agro-engineering measures, and the removal of nitrates from the groundwater drinking sources. On the basis of a theoretical survey, the following agro-engineering measures for protection of groundwater against nitrate pollution were selected as basic: manuring with reduced contents of nitric fertilizers; fractioned insertion of nitric fertilizers in accordance with the vegetation phases of intensified growing; introduction of suitable crop-rotations in the sanitary-protective spots and the water-collecting regions of water seizing equipments. Four variants to traditional nitric fertilization were tested and evaluated for economic effects on crop production. Nitrate removal from drinking water by means of ion-exchange was used as a basis for defining the comparative efficiency of agro-engineering measures for preservation of groundwaters from nitrogen pollution. In applying these principles to the town of Stara Zagora, it was shown more profitable for society to preseve groundwaters both through the reduction of nitric fertiliation rate by one-thire and through fractioned insertion of fertilizers or adoption of suitable crop-rotations, as compared to the technological variant for drinking water purification through ion-exchange. The proposed methods also allow the calculation of losses to farmers caused by these measures and the determination of the size of their compensations. (Geiger-PTT)
W88-01405

SUMMARY OF GROUNDWATER POLLUTION PROBLEMS IN SOUTH DAKOTA,
South Dakota Dept. of Water and Natural Resources, Pierre.
M. Meyer.
1985 State/EPA Task 2.3.1-111B, April 1986. 18 p, 2 tab, 26 ref.

Descriptors: *South Dakota, *Groundwater pollution, *Water pollution sources, *Nonpoint pollution sources, *South Dakota, *Leaching, Fate of pollutants, Wells, Farm wastes, Agricultural runoff, Wastewater treatment, Leachates, Oil spills, Mine wastes, Urban runoff, Feedlots wastes, Farm wastes.

In the area of groundwater pollution, the two biggest problems facing the State of South Dakota are: the contamination of public wells from leaks and spills and; contamination of domestic wells from feedlots, barnyards, and septic systems. Most contamination of public water supply wells occurs from spills and leaks of petroleum products and agricultural chemicals from storage tanks. Contamination of domestic and stock wells from nitrate and bacteria is the second major groundwater problem facing the State. Existing or potential groundwater pollution problems that are discussed include: petroleum and chemical leaks and spills; poor domestic well construction and locations practices; feedlots, barnyards, and stockyards; domestic septic systems, municipal wastewater treatment and disposal, landfills and dumps, hazardous materials, nonpoint agricultural sources, inter-aquifer leakage, oil and gas activities, mining activities, urban area related activities; and other miscellaneous sources such as water treatment sludges, agricultural drainage wells, geothermal wells, disposal of dredge fill materials, agricultural food processing, coal and fly ash storage ponds, cooling ponds, back-siphoning of chemicals into private and public wells, and cattle dipping pits. Except for the relatively rare occurrence of methemoglobinemia, no health problems have apparently ever been documented from groundwater pollution sources in the State. Because of the high cost of cleaning up groundwater problems, prevention must be emphasized to protect this vital resource. (Geiger-PTT)
W88-01406

ACID MINE DRAINAGE PROBLEMS IN ENUGU COAL MINES OF ANAMBRA STATE, NIGERIA,
Anambra State Univ. of Technology, Awka (Nigeria). Dept. of Earth Sciences.
B. C. E. Egboka, and K. O. Uma.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 1-11, 4 fig, 4 tab, 17 ref.

Descriptors: *Coal mining, *Acid mine drainage, *Path of pollutants, *Nigeria, *Groundwater movement, *Groundwater pollution, Mine drainage, Enugu, Aquifers, Geohydrology.

Coal mining in the Enugu area began in 1915. Until the advent of Nigerian oil, coal served as the primary source of energy. Interest in the coal industry revived with advances in the Nigerian steel industry. The physical characteristics, geohydrology, and geochemistry of the area were detailed. Five coal seams occur in the Mamu Formation, with the No. 3 seam maintaining a workable thickness in excess of 1.5 m. Overlying the coaliferous formation is the Ajali Sandstone consisting of thick, friable, poorly-sorted sandy units of alternating cross-bedded coarse and fine sands with shale/

mudstone intercalations. The Ajali Sandstone and the overlying laterite/red earth have a high vertical permeability. The formations are intensely fractured, jointed, and faulted. Fracture connectivity between aquifers indicates possible hydrogeologic continuity across formations. High yielding aquifers exist in Ajali Sandstone and the Mamu Formation. Large groundwater flows through fractures are continuous though the source of the water is still uncertain. About 18.1 million liters of acidic water with high iron content is pumped out daily into nearby rivers. Possible sources of the acid mine drainage and its hydrogeochemistry were explored. Suggestions were presented for alleviating the problems and hazards associated with coal mining under these conditions which would reduce the present waste of financial and material resources and the damage to mine equipment. (See also W88-01408) (Wood-PTT)
W88-01409

ORIGIN AND TREATMENT OF UNDERGROUND WATERS FROM CERRO DE PASCO MINE, PERU,
Centromin Peru S.A., Lima (Peru).
R. L. Bernal, and O. D. Venero.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 27-40, 7 fig, 10 ref.

Descriptors: *Mine drainage, *Groundwater movement, *Mineral industry, *Water pollution treatment, *Water pollution sources, *Groundwater pollution, Groundwater, Cerro de Pasco Mine, Peru, Lead, Zinc, Silver, Metals, Leaching, Geohydrology, Drainage, Alkaline water, Acidic water.

The Cerro de Pasco mine is one of the most complex run by Centromin Peru S.A. in Central Peru. Underground and open pit mining for lead-zinc-silver and in-situ leaching, as well as dump leaching, are carried out over bordering areas. The many operations involved pose complex technological and operational problems. The geological and hydrogeological characteristics of the deposit are discussed in relation to the origin of the mine water. Around 5,800 GPM of alkaline waters and acid solutions are collected at the mine at different levels the lowest of which was 2100 feet below the surface. The acid solutions containing copper and iron-sulfur bacteria are used as leachants at the in-situ and dump leaching operations. this leaves a total of 3,200 GPM of the pregnant copper solutions, to be finally treated at a SX-EW Plant, whose output is 5,000 Tns/year of refined copper cathodes. (See also W88-01408) (Author's abstract)
W88-01411

HEAVY METALS IN WATER ORGANISMS.
Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. 441 p. Edited by J. Salanki.

Descriptors: *Heavy metals, *Bioindicators, *Water pollution effects, *Path of pollutants, *Aquatic life, Fish, Molluska, Crustaceans, Macrophytes, Toxicity, Ecological effects, Aquatic plants, Algae, Plankton, Bioaccumulation, Trace metals, Lakes, Marine animals, Excretion.

The papers in this volume were presented at a symposium held in Hungary at which scientists from 12 countries provided information on the latest results in the field of heavy metals in aquatic organisms. The most important topics discussed were the accumulation of heavy metals, ecological monitoring of heavy metal pollution, organisms as bioindicators, and the effect of heavy metal pollution on vital function. The Hungarian participants gave an account of the state-of-the-art of research into the heavy metal pollution of Lake Balaton. Chemical substances of anthropogenic origin polluting surface waters are dangerous to aquatic organisms and have varying effects on microbes, plants, and animals. Living organisms frequently accumulate pollutants, signalling in this way their presence in the environment. Accumulation is particularly characteristic of heavy metals entering surface waters as industrial, agricultural and communal wastes. Heavy metals have come into the focus of environmental biological research all over the world. Beyond the monitoring of pollution, special attention is being paid to the various organisms which make early detection possible. (See W88-01461 thru W88-01492) (Geiger-PTT)
W88-01460

UPTAKE OF SELECTED HEAVY METALS BY THE GREEN ALGA CLADOPHORA GLOMERATA,
Polytechnic of Central London (England). Applied Ecology Research Group.
B. M. McHardy, and J. J. George.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 3-17, 4 fig, 9 tab, 19 ref.

Descriptors: *Heavy metals, *Chlorophyta, *Bioaccumulation, *Nonpoint pollution sources, *Urban runoff, *Path of pollutants, *Water pollution effects, Highway effects, Rivers, Ecological effects, Lead, Nickel, Cadmium, Copper, Zinc, Iron, Manganese, Biological magnification, Heavy metals.

The uptake of metals by Cladophora glomerata in an urban river, the Roding, receiving motorway, urban and nonpoint runoff was examined as part of a ten year program on the effects of motorway and urban runoff on the macrophyte and invertebrate communities in an urban river. Algae samples taken from seven sites selected from the middle reaches of the river were analyzed for Pb, Cd, Cu, Ni, Zn, Mn, and Fe. Analyses of heavy metals in water samples from the sites showed that concentrations of total Pb, Cu, and Mn were generally lower at site 1, the control site. A marked increase occurred at site 2 indicating a metallic input above this site with Cu concentrations peaking here. Pb, Ni, and Zn continued to increase downstream of the control site and achieved maximum mean levels at site 3. Site 4 displayed a decline in metal levels but this process was soon reversed a few kilometers downstream at sites 5 and 6 with Fe peaking at the latter. Several roadway drainage channels contributed intermittently to the heavy metal content of site 3. Metals were present in higher concentrations in algal tissue than in the water itself. Statistically significant differences in algal metal concentrations between sites were obtained for only three of the metals (Zn, Pb, and Fe). Maximum mean concentrations of Pb, Cu, Zn, and Fe were recorded at site 4, while Cd peaked at site 3, and Ni and Mn peaked at site 7. Some concentration factors were remarkably constant with time. Other research on metal concentration factors in Cladophora shows close agreement with the findings of this survey. (See also W88-01460) (Geiger-PTT)
W88-01461

HEAVY METAL ACCUMULATION AND PHYSIOLOGICAL EFFECTS ON AUSTRIAN MACROPHYTES,
Vienna Univ. (Austria). Inst. fuer Pflanzenphysiologie.
G. A. Janauer.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 21-28, 6 fig, 11 ref.

Descriptors: *Bioaccumulation, *Macrophytes, *Heavy metals, *Aquatic plants, *Bioindicators, *Path of pollutants, *Water pollution effects, Copper, Cadmium, Nickel, Toxicity, Carbohydrates, Organic matter, Amino acids.

The accumulation of Cd, Cu, and Ni in the macrophytes Myriophyllum spicatum, Potamogeton coloratus, and P. pectinatus was studied in laboratory tests. Results in the laboratory resembled closely those detected in plants which were sampled from natural habitats. The level of starch or of different sugars or potassium acted as an indicator for the eutrophication effects on aquatic plants. If the plants did not die within the exposure time of two weeks under the effect of Cu, the starch level invariably increased irrespective of the heavy metal added or the species analyzed. The soluble carbohydrates, similar to starch, in almost all cases showed a higher concentration after a fortnight than at the start of the experiment. In contrast, the amino acids usually decline towards the end of the fortnight. If the exact uptake behavior of aquatic plants is known, it is suggested that these plants be used as active monitors within standard periods of exposure to detect pollutants. The changes in the organic substances caused by heavy metal pollution were reproducible and therefore could also be used as an indicator of heavy metal pollution. (See also W88-01460) (Geiger-PTT)
W88-01462

DISTRIBUTION OF HEAVY METALS IN AQUATIC MACROPHYTES FROM OKEFENOKEE SWAMP,
Louisville Univ., KY. Systems Science Inst.
R. W. Bosserman.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 31-39, 2 fig, 2 tab, 17 ref. NSF Grant Nos. DEB 76-12292 and DEB 78-08842.

Descriptors: *Heavy metals, *Swamps, *Bioaccumulation, *Macrophytes, *Aluminum, *Path of pollutants, Strontium, Iron, Copper, Zinc, Silicon, Cobalt, Chromium, Mercury, Nickel, Lead, Cadmium, Water pollution effects, Wetlands, Aquatic plants.

Elemental concentrations of eight aquatic macrophytes: white water lily (Nymphaea odorata Ait.), yellow water lily (Nuphar advena Ait.), pickerel weed (Pontederia cordata L.), yellow eyed grass (Xyris smaliana Nash.), beakrush (Rhynchospora inundata (Oakes) Fern.), redroot (Lachnanthes caroliniana (Lam.) Dandy), sphagnum (Sphagnum cuspidatum var. serrulata Schlieph.), and bladderwort (Utricularia sp.) were measured in Okefenokee Swamp during October 1977. Iron, aluminum, copper, zinc, silicon, cobalt, chromium, nickel, lead, cadmium, and strontium were analyzed in plant parts and in various Okefenokee locations. Mercury was also analyzed for in Utricularia. In general, concentrations were lower than in the same species found outside Okefenokee Swamp, which reflects its unpolluted and ombrotrophic state. Differences in plant parts explained more variation in elements than location. Nuphar stems, Utricularia, Lachnanthes leaves, and Sphagnum had highest concentrations of most elements. (See also W88-01460) (Author's abstract)
W88-01463

HEAVY METAL CONTENT IN MACROPHYTES FROM PONDS SUPPLIED WITH POST-SEWAGE WATER,
Warsaw Univ. (Poland). Dept. of Hydrobiology.
T. Ozimek.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 41-49, 5 fig, 15 ref.

Descriptors: *Heavy metals, *Macrophytes, *Biological wastewater treatment, *Biofiltration, *Ponds, *Path of pollutants, Water pollution effects, Iron, Manganese, Zinc, Copper, Lead, Chromium, Nickel, Duckweed, Aquatic plants, Sediments, Bioaccumulation, Adsorption.

The role of various ecological groups of aquatic plants (helophytes and elodeids) in cycling heavy metals in ponds supplied with post-sewage water was studied at the sewage treatment plant at Pruszkow near Warsaw. The concentrations of Fe, Mn, Zn, Cu, Pb, Cr, and Ni were determined in samples of plants by atomic absorption spectrophotometry. The content of heavy metals in post-sewage water differed considerably in successive months of investigations. The mean content of the majority of metals in water decreased in successive ponds. The contents of heavy metals in sediments, similarly as in water, decreased in successive ponds. The contents of Fe, Mn, Cu and Cr were the highest in submerged macrophytes and the lowest in aboveground parts of emergent plants. The content of heavy metals in pleustonic plants decreased with the heavy metal content in water. The pleustonic plants are recommended for removing heavy

metals from water because they are almost equally efficient as submerged macrophytes, grow well in polluted environments, can be easily removed from the environment, and are not limited by light conditions. They draw heavy metals directly from water, and do not set in motion metal deposition in sediments. (See also W88-01460) (Geiger-PTT)
W88-01464

ACCUMULATION, TOXICITY AND LOCALIZATION OF LEAD IN CRYPTOGAMS: EXPERIMENTAL RESULTS,
Hamburg Univ. (Germany, F.R.). Inst. fuer Allgemeine Botanik.
D. Lorch, and A. Weber.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 51-59, 3 fig, 14 ref. Deutsche Forschungsgemeinschaft Grants Lo 216/1-8.

Descriptors: *Heavy metals, *Path of pollutants, *Toxicity, *Bioaccumulation, *Algae, *Lead, Fate of pollutants, Adsorption, Biomass, Hydrogen ion concentration, Water temperature, Plant growth, Water pollution effects, Plant physiology, Detoxification.

An abbreviated overview of the results of studies undertaken at the Institut fuer Allgemeine Botanik of the University of Hamburg pertaining to metal accumulation, toxicity, localization, and ultrastructural changes of aquatic plants is presented. Metal accumulation by algae and other aquatic cryptogams is influenced by a number of abiotic and biotic factors. Some algae showed increased Pb concentrations with higher external Pb concentrations in water. In most of the organisms examined, time dependent Pb accumulation followed saturation kinetics, with differences occurring only in the final metal content and the time elapsed until equilibrium is reached. In the usual nutrient media, addition of Pb led to the formation of precipitates, making Pb no longer available for accumulation by the experimental organism. Precipitation can be prevented by omitting phosphate and sulfate ions from the experimental medium. A distinct influence of the water temperature on Pb accumulation was observed. Increasing the biomass resulted in decreasing the metal concentration in algae. In short time experiments (up to 48 hr) the effect of Pb offered in the ionic form on plants was drastic; growth was stunted and several ultrastructural changes occurred. The cell wall was shown to play an important role in metal accumulation. (See also W88-01460) (Geiger-PTT)
W88-01465

HEAVY METALS AND MINERAL NUTRIENT BUDGET IN PHRAGMITES AUSTRALIS AND TYPHA ANGUSTIFOLIA,
Polish Academy of Sciences, Mikolajki. Inst. of Ecology.
I. Kufel, and L. Kufel.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 61-66, 2 fig, 4 tab, 5 ref.

Descriptors: *Path of pollutants, *Heavy metals, *Nutrients, *Macrophytes, *Minerals, *Bioaccumulation, Aquatic plants, Water pollution effects, Littoral zone, Lakes, Phosphorus, Copper, Cadmium, Lead, Cobalt, Molybdenum, Manganese, Seasonal variation, Cattails, Absorption, Leaching, Decomposition.

The flow of heavy metals (Cu, Cd, Pb, Co, Mo and Mn) through reed and cattail and the changes in P content of reed were traced under natural background conditions in Lake Gardynskie, Poland. The analysis of the seasonal changes in concentration of investigated elements in shoots revealed three main types of accumulation dynamics. The first is characterized by a sharp maximum in early summer followed by a slow decrease later on during the rest of the season and is represented by the accumulation of Mo in reed and cattail. In the second type, the amount of elements in plant shoots is nearly constant during the whole season as seen in the accumulation of Pb, Cd, and Co in both analyzed plants. The changes of elements in the third type strictly followed the seasonal changes of plant biomass with a maximum in September as seen in P, Mn, and Cu concentration changes. Heavy metal uptake was, to a high degree, species specific. The loss of elements accumulated in plant shoots occurred through leaching by rain from living biomass during the vegetative season and the decomposition of plant detritus. The process of leaching from living shoots was significant only for Pb. Nearly 30% of accumulated metals and 46% of P were released from decomposing reed to littoral water in the early phase of plant decomposition. The respective values for cattail were 3-22% of metals. High percentages of Pb leached out from living biomass, up to 70% from cattail and 7% from reed, with a nearly constant amount of metal in shoots during the season. P was not sorbed by littoral sediments and was easily released by decomposing reed, and may strongly influence the total nutrient euilibrium in the littoral zone of lakes. (See also W88-01460) (Geiger-PTT)
W88-01466

CONCENTRATION OF MICROELEMENTS IN THE AQUATIC WEEDS OF LAKE BALATON,
University of Agriculture, Godollo (Hungary). Dept. of Botany and Plant Physiology.
M. Kovacs, I. Nyari, and L. Toth.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 67-80, 6 tab, 10 ref.

Descriptors: *Heavy metals, *Trace elements, *Macrophytes, *Lakes, *Biological magnification, *Path of pollutants, *Ecological effects, *Bioaccumulation, Aquatic plants, Lake sediments, Toxicity, Environmental effects.

The microelement content of the water of Lake Balaton, Hungary is described in relation to the uptake of these substances by the macrophytic aquatic vegetation, especially the submerged weeds, and lake sediments. Thirty-three elements, 17 of which are toxic, were detected in nine water samples. One source of the elements is the diversified geochemical environment in the watershed of the lake and along its shore. The submerged weeds accumulate rare elements in extremely different quantities. In the submerged and floating weeds, the concentration factor of some microelements may be as high as 100,000 to 1,000,000. In the organs of Phragmites communis, Typha angustifolia, T. latifolia and Glyceria maxima the elements taken up from the sediment and, in the case of the adventitious roots of reed, from the water are translocated to different extents. In Phragmites communis, Glyceria maxima, Typha latifolia, and T. Augustifolia most microelements are accumulated in the subterranean organs. As a result of environmental pollution, the two Typha species rapidly spread replacing reed stands. The Typha are capable of accumulating larger amounts of microelements than reed. (See also W88-01460) (Geiger-PTT)
W88-01467

LEAD IN A PELAGIC FOOD CHAIN,
Moss Landing Marine Labs., CA.
A. R. Flegal.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 83-89, 1 fig, 20 ref.

Descriptors: *Lead, *Food chains, *Biological magnification, *Path of pollutants, *Pacific Ocean, *Bioaccumulation, *Calcium, Marine animals, Marine plants, Heavy metals, Phytoplankton, Fish, Zooplankton, Trophic levels, Sorption, Crustaceans, Toxicity, Water pollution effects, Ecological effects.

The pelagic food chain of the central Pacific exhibits a bioenrichment of Ca with respect to Pb in the primary and secondary trophic levels and a biopurification in higher trophic levels. Phytoplankton contains an elevated atomic ratio of Pb to Ca relative to that of sea water. The bioenrichment in zooplankton is attributed to their digestion of the bioenriched organo-lead complexes of phytoplankton and their elimination of the biopurified calcareous shells of phytoplankton, as well as the preferential complexation of Pb relative to Ca on zooplankton surfaces. The biopurification in fish is attributed to their relatively reduced sites for surface complexation and the efficiency of metabolic biopurification processes. Pb fluxes to the marine environment have been perturbed by anthropogenic emissions of Pb which now exceed natural emissions of Pb by two orders of magnitude. Pb concentrations in marine organisms also exhibit this perturbation. Pb concentrations were normalized to Ca concentrations because of the similarities in their biological uptake, internal distribution and excretion to calculate Pb contamination in a pelagic food chain using the Pb to Ca atomic ratios of intertidal organisms and pelagic fish. While the Pb concentrations are lower than commonly reported, they are at least one order of magnitude above natural levels. Since the marine food chain is less efficient in the biopurification of Pb than terrestrial systems, marine organisms may now be subjected to comparable or greater levels of sublethal Pb toxicity than terrestrial organisms. Future studies of the Pb cycle in the marine biosphere should concentrate on its sublethal effects in the primary and secondary trophic levels, using the ultra-clean techniques required for accurate Pb measurements. (See also W88-01460) (Geiger-PTT)
W88-01468

HEAVY METAL CONTENT OF THE FISHES OF LAKE BALATON, DANUBE AND TISZA DURING THE PERIOD OF 1979-1982,
Magyar Tudomanyos Akademia Talajtani es Agrokemiai Kutatointezete, Budapest.
S. Gaal, I. Fuzesi, and B. Penzes.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 91-104, 6 fig, 14 tab, 13 ref.

Descriptors: *Heavy metals, *Fish, *Lakes, *Lead, *Rivers, *Path of pollutants, Mercury, Cadmium, Manganese, Copper, Zinc, Carp, Pike, Perch, Muscle, Bioaccumulation, Water pollution effects, Tissue analysis, Environmental effects, Ecological effects.

A study was performed in 1979-1982 on the heavy metal content of some characteristic species of Lake Balaton, the Danube and the Tisza Rivers, i.e. barbel (Barbus fluviatilis L.), carp (Cyprinus carpio L.), bream (Abramis brama L.), and pike-perch (Stizostedion lucioperca L.). The heavy metal content of the muscular tissues of the species investigated - apart from one specimen - did not surpass the limit allowed in the majority of the European countries. However, the muscle samples of the Danube barbel contained 8.89 mg/kg Pb instead of the accepted 2.5 mg/kg. This was attributed to the intensive pollution of the Danube River. In addition to Pb, the following elements were also investigated: Hg, Cd, Mn, Cu and Zn. It was established that the muscular parts serving as food contain significantly less heavy metal than that allowed for public consumption. It was also noted that the fish in the Tisza River proved to be minimally contaminated with the heavy metals analyzed. (See also W88-01460) (Author's abstract)
W88-01469

ACCUMULATION OF HEAVY METALS IN AQUATIC ORGANISMS OF SEWAGE WATER TREATMENT PLANTS,
Hajdu-Bihar County Water Canalization Works, Debrecen (Hungary).
I. Czegeny, and I. Devai.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 105-110, 1 tab, 11 ref.

Descriptors: *Heavy metals, *Aquatic animals, *Bioaccumulation, *Wastewater facilities, *Path of pollutants, Daphnia, Midges, Oligochaetes, Wastewater treatment, Zinc, Copper, Iron, Molybdenum, Domestic wastes, Industrial wastewater, Atomic absorption spectrophotometry, Water pollution effects.

The content of Zn, Cu, Fe, and Mo in Moina rectirostris, Daphnia magna, Sigara lateralis, Chironomus annularius and Oligochaeta living in the biomechanical combined oxidation (BMKO) sewage treatment systems of two different Hungarian wastewater facilities were determined by atomic absorption spectrophotometry. The Hajduboszormeny plant received both domestic and industrial sewage while the Puspokladany plant received mainly domestic sewage. Results showed that the heavy metal accumulations of the aquatic organisms were very different for the two treatment facilities. Zn accumulation in organisms was fairly significant in the BMKO system of Hajduboszormeny, especially in Moina rectirostris. Organisms of the BMKO system of Puspokladany have a lower Zn accumulation than the organims of the other BMKO system. In both systems, higher Zn concentrations were determined in organisms living in the water than in bottom-dwelling ones. Cu concentrations have the same characteristics as the quality relations of Zn. Fe concentrations in organisms are high in relation to other heavy metal contents. Very high Mo contents of organisms living in the BMKO of Hajduboszormeny related to those of Puspokladany were noted illustrating the effects of industrial effluents with very high Mo content at the Hajduboszormeny facility. (See also W88-01460) (Geiger-PTT)
W88-01470

ACCUMULATION AND EFFECT OF HEAVY METALS IN THE FISHES OF LAKE BALATON,

Orszagos Allategeszsegugyi Intezet, Budapest (Hungary).
M. H.-Miklovics, E. Kovacs-Gayer, and J. Szakolczai.

IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 111-117, 3 tab, 8 ref.

Descriptors: *Heavy metals, *Fish, *Lakes, *Toxicity, *Bioaccumulation, *Water pollution effects, *Path of pollutants, *Tissue analysis, Fish physiology, Carp, Pike, Perch, Copper, Zinc, Muscle, Cadmium, Lead, Liver, Seasonal variation, Kidneys, Gills, Atomic absorption spectrophotometry.

Common carp, pike-perch and bream from the catch of three different areas of Lake Balaton were examined for Cu, Cd, Zn and Pb in muscle and liver and sometimes in kidneys, intestine, skin, and gills. Fish were sampled usually every month or about 10 times each year in a project that started in 1976. Results showed that the quantity of heavy metals did not reach the toxic level. Heavy metal content varied between the different organs of the fish. Also, there were differences between the same organs of fishes belonging to different species. Zn content was several times higher than the Cu content. In bream and particularly in carp the residues were higher than in pike-perch. There was no significant difference between the same fish species originating from the three areas. In control fishes collected from different places the heavy metal residues were generally lower than in fishes from Lake Balaton. In pike-perch, heavy metal residue levels were nearly constant throughout the year, and the maximum levels generally did not exceed those allowed by the Ministry of Health. There was no correlation between the amount of residues found by toxicological analysis and the histopathological changes. In the common bream less expressed and in the common carp more pronounced seasonal fluctuation was observed. These data indicated that the pollution of Lake Balaton is not yet high enough to cause chronic toxicosis or to damage the health of fishes. (See also W88-01460) (Geiger-PTT)
W88-01471

SEASONAL AND LOCAL VARIATION IN THE HEAVY METAL CONCENTRATION IN ANIMALS OF LAKE BALATON,

Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
K. V.-Balogh.

IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 119-138, 13 fig, 19 ref.

Descriptors: *Heavy metals, *Bioaccumulation, *Bioindicators, *Seasonal variatio, *Aquatic animals, Mussels, Crustaceans, Plankton, Lakes, Monitoring, *Path of pollutants, *Tissue analysis, Water pollution effects, Cadmium, Mercury, Lead, Copper, Water pollution sources, Muscle, Gills.

The concentrations of Hg, Cd, Pb and Cu were measured in the mussel Unio and in the crustacean plankton collected at different regions of Lake Balaton in various season of the year. The concentration of Hg varied between 0.236-0.964 mg/kg at the 10 sampling stations. In general, values were higher closer to the shore than in the center of the lake and there was a reduction of Hg concentration in samples towards the east. Concentrations of Cd varied between 1.26 and 35.0 mg/kg. Higher values were measured in crustaceans collected in the western part of the lake both close to the shore and to the middle line. A high value was found also at the most eastern point close to the shore. Cu concentrations were in the range of 8.38 and 57.3 mg/kg. No significant differences were found in the samples taken in the middle of the Lake; however, high values were measured in samples collected at the western part, close to the shore. Pb levels varied in the crustacean plankton between 11.6 and 61.0 mg/kg. Highest values occurred in the samples taken in the center of the western basin. There were differences between values of Hg, Cd, and Pb concentrations of the crustacean plankton collected in three different seasons. Seasonal sampling was carried out for mussels at the western part of the lake. For this species, concentrations of Hg and Pb remained at the same level in the gills between April and September, while Cu increased by about 10-fold and Cd doubled. The concentration of Pb and Hg doubled in the foot in summer, and the concentration of Cu increased up to September. In the adductor muscles, no significant differences were found in the Pb concentrations between April and September, but Cu was three times higher in summer as compared to the April mean value. The Hg and Cd concentrations decreased in June. In the mantle, the Hg levels were seven times higher in summer as compared to the April values. Cu showed a very high concentration in the gills, in the adductors and in the mantle as compared to the values measured in mussels collected from the open water of the lake. Higher Pb values were measured in the gills and in the foot, and higher Cd values were found in the gills. (See also W88-01460) (Geiger-PTT)
W88-01472

HEAVY METALS IN MARINE ORGANISMS,

Akademiya Nauk Latviiskoi SSR, Riga. Inst. of Biology.
I. Kulikova, Z. Seisuma, and M. Legzdina.

IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 141-150, 4 fig, 3 ref.

Descriptors: *Heavy metals, *Toxicity, *Marine animals, *Bioaccumulation, *Marine algae, *Bioindicators, *Path of pollutants, *Tissue analysis, Marine plants, Benthos, Fish, Lamprey, Crustaceans, Mollusks, Plankton, Atomic absorption spectrophotometry, Gulfs, Water pollution sources, Liver, Muscle, Gills, Ecological effects.

The levels of 13 metals (Hg, Cd, Co, Ni, Cu Pb, Sr, Zn, Mn, Fe, Mg, and Ca) in total plankton, benthic organisms, algae, and fish of the Gulf of Riga and separate parts of the open Baltics were investigated. Metal concentrations (except Hg) were measured by atomic absorption spectrophotometry. Hg was determined by Coleman analyzer. The amount of Hg, Co, Cr, and Cd found in plankton was the lowest, followed by Ni, Cu, and Pb. Medium levels of Sr, Zn, and Mn were recorded, while the highest levels found in plankton belong to Fe, Mg, and Ca. In bivalve mollusks the ability to accumulate metals from marine water is higher than in other water organisms. In comparison with mollusks smaller amounts of Fe, Mn, Zn, Sr, Ca, and Mg are found in algae, and the level of Cr, Hg, and Cd in them is very low. A selective accumulation of certain metals was noted in benthic crustaceans which was related to the variability in chemical composition of biotope of these species, their way of life, metabolism and the difference in nutrition. Thirteen species of fish from the Gulf of Riga were analyzed according to the metal level accumulated in them. The amount of metals distributed in fish organs and tissues differs considerably; it is mainly localized in bones, gills, fins, liver, and spawn. The levels of Ca, Mg, Fe and Zn are high in all the fish organs and tissues while the levels of Cd, and Hg are insignificant in them. Liver has a high concentration of Cu, Ni, Pb, Zn, Fe, Mg, and Ca. The amount of Cu in liver exceeds that in other organs and tissues by several times. Hg is accumulated in muscles. Seasonal fluctuation in metal accumulation is best seen in separate organs than in the whole organism. The amount of metals in various organs and tissues appears to be a variable quantity closely depending on metabolism and a number of environmental factors. (See also W88-01460) (Geiger-PTT)
W88-01473

FREQUENCY OF BACTERIA RESISTANT TO HEAVY METALS IN PONDS OF SOUTHERN BOHEMIA,

Ceskoslovenska Akademie Ved, Prague. Ustav Krajinne Ekologie.

For primary bibliographic entry see Field 5C.
W88-01474

TOTAL MERCURY CONTENT IN THE COMPONENTS OF RUNNING WATER, RESERVOIR AND POND ECOSYSTEMS IN CZECHOSLOVAKIA,

Vyzkummny Ustav Rybarsky Vodnany (Czechoslovakia).
Z. Svobodova, and M. Hejtmanek.

IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 171-177, 3 tab, 8 ref.

Descriptors: *Heavy metals, *Mercury, *Fish, *Czechoslovakia, *Ponds, Bioaccumulation, *Path of pollutants, Toxicity, Muscle, Reservoirs, Ecosystems, Carp, Pike, Perch, Catfish, Bioindicators, Food chains, Lake sediments, Aquatic plants, Aquatic insects.

Investigation of total Hg content in individual components of aquatic ecosystems was carried out at 12 localities of the Berounka river catchment area in Czechoslovakia. A total of 1187 individuals of 23 fish species were analyzed. The highest content of Hg in fish muscle was found in fish from localities below Pilsen, and the lowest one from localities above Pilsen and Prague. The average value of total Hg content in most fish species ranged between 0.10-0.30 mg/kg of muscle. The highest Hg content was found in predatory fish species, followed by benthos feeders (barbel and dace). The barbel can serve as a suitable bioindicator of environmental pollution by Hg. Hg content determined in surface water was not a decisive indicator of the extent of water environmental pollution. Total Hg content in the samples of bottom sediments from the localities of the Berounka river basin ranged between 0.18-3.66 mg/kg Hg in dry matter of sediment. Total Hg content in samples of aquatic plants, algae, moss mats, mayflies, sedge flies and leeches was 10 times lower compared with the values for fish muscle. The highest Hg content was found in leeches. The occurrence of Hg in carp organs and tissues is as follows: muscle > kidney > liver. The maximum admissible concentration of 0.1 mg/kg of Hg in fish muscle was never exceeded. The values of total Hg content in water were low in all ponds studied and corresponded to natural Hg concentration in waters. These results document the low Hg pollution of fish ponds with different catchment area character. Increased concentrations of Hg were not detected even in individual components of water biocenosis in the ponds loaded with powerplant and industrial wastes. (See also W88-01460) (Geiger-PTT)
W88-01475

BIOINDICATORS FOR THE HEAVY METAL LOAD OF RIVER ECOSYSTEMS,

Bayerische Landesanstalt fuer Wasserforschung, Munich (Germany, F.R.).

For primary bibliographic entry see Field 5A.
W88-01476

HEAVY METAL AND RADIONUCLIDE TRANSFER AND TRANSPORT BY MARINE ORGANISMS,
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
S. W. Fowler.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 191-205, 3 fig, 4 tab, 42 ref.

Descriptors: *Heavy metals, *Radioisotopes, *Marine animals, *Bioaccumulation, *Path of pollutants, Marine sediments, Food chains, Water pollution effects, Biological magnification, Adsorption, Excretion, Trace elements, Sediment transport.

All marine organisms accumulate metals and radionuclides to some degree, and as a result redistribute these elements by various physiological mechanisms and through their ecological behavior. Water, food and sediments are the three source terms from which marine biota acquire metals and radionuclides. Uptake from water can occur by passive surface adsorption, absorption across body surfaces, or a combination of both. Elements ingested with food are either absorbed across the gut and assimilated into tissue or they are excreted. The relative importance of the food and water pathway in uptake varies with the element and the conditions under which exposure occurs. Less is known about mechanisms of uptake from sediments, but most evidence suggests that, compared to water and food, bioavailability from sediments is relatively low. These dynamic processes are controlled by many environmental and intrinsic factors including exposure time, physical-chemical form of the pollutant, salinity, temperature, competitive effects with other elements, organism size, physiology, life cycle and feeding habits. Accumulated metals and radionuclides are transported actively by vertical and horizontal migrations of organisms and, more important, passively by release of biogenic particulates (fecal pellets, molts, etc.). As these particles sink, they release contaminants to deeper waters and sediments through remineralization processes, scavenge other elements from the water column and are ingested by meso- and bathypelagic species. Potential biological mechanisms for returning sediment-associated contaminants to the upper waters are also discussed. (See also W88-01460) (Author's abstract)
W88-01477

COMBINED EFFECT OF MERCURY AND CADMIUM ON PLANKTON IN SITU,
Akademiya Nauk Latviiskoi SSR, Riga. Inst. of Biology.
For primary bibliographic entry see Field 5C.
W88-01478

SOME PROBLEMS OF POLLUTION WITH HEAVY METALS UNDER THE ENVIRONMENTAL CONDITIONS OF THE BALTIC SEA,
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
For primary bibliographic entry see Field 5C.
W88-01479

INFLUENCE OF SIZE UPON THE CONCENTRATIONS OF CD, CR, CU, HG, PB AND ZN IN THE COMMON MUSSEL (MYTILUS EDULIS L.),
Aarhus Univ. (Denmark). Botanical Inst.
For primary bibliographic entry see Field 5C.
W88-01481

TRACE METALS IN EDIBLE CRUSTACEANS FROM LEBANON,
Shiber Consultants, Safat (Kuwait).
J. G. Shiber.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 285-295, 1 fig, 3 tab, 16 ref.

Descriptors: *Shrimp, *Lobsters, *Heavy metals, *Water pollution effects, *Path of pollutants, *Bioaccumulation, Lead, Cadmium, Copper, Nickel, Iron, Zinc, Chromium, Water pollution sources, Toxicity, Atomic absorption spectrophotometry, Trace metals, Crustaceans, Tissue analysis.

Samples of the shrimp, Penaeus japonicus, and the lobster, Scyllarides latus were collected at locations between Tripoli and Tyre, Lebanon and analyzed for content of Pb, Cd, Cu, Ni, Fe, Zn, and Cr by atomic absorption spectrophotometry. Pb and Cd levels in the shrimp were relatively stable with a few elevated readings in each tissue at different locations. Cu was somewhat higher in the shrimp muscle than exoskeleton, except at Beirut, Damour, and Sidon. Ni was variable, although the higher concentrations seemed to occur mainly in the exoskeleton. Fe was also very variable in both muscle and exoskeleton, while Zn was consistently higher in shrimp muscle. Cr was slightly variable. Pb and Cd readings in the lobster were fairly uniform and similar to those of the shrimp. Cu seemed generally lower in lobster than shrimp, and there was little difference between muscle and exoskeleton Cu levels in most of the samples. Lobster muscle from Beirut had considerably higher Cu than any of the other samples. Ni was variable, with comparatively high readings in both the muscle and exoskeleton of samples from Tyre. Fe was also variable, but it was clearly more highly concentrated in the exoskeletal tissue of each lobster analyzed, except for samples from Tyre. Zn was highest in most muscle samples, except those from Tyre. Cr was slightly variable with relatively higher values in samples from Tyre. Several sources for heavy metal pollution off the coast of Lebanon include traffic from oil tankers and the dumping of raw sewage into rivers and streams which terminate at the Mediterranean Sea. (See also W88-01460) (Geiger-PTT)
W88-01483

TISSUE ACCUMULATION OF HEAVY METALS AND THEIR INFLUENCE ON THE BIOSYNTHESIS IN THE FISH ORGANISM,
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
V. D. Romanenko, and N. Y. Yevtushenko.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 299-312, 8 fig.

Descriptors: *Bioaccumulation, *Heavy metals, *Fish, *Biosynthesis, *Metabolism, *Path of pollutants, Manganese, Zinc, Cobalt, Copper, Water pollution effects, Liver, Excretion, Carp, Blood, Models, Muscle, Tissue analysis, Biochemistry.

The dependence of the biosynthetic tendency of metabolism in fishes exposed to different concentrations of the heavy metal ions of Mn, Zn, Co, and Cu in water was examined in aquariums. Using radioisotope assay, it was found that both the intensity and direction of biosynthesis in fishes exposed to various concentrations of heavy metal ions in water are determined by their own concentration, duration of the impact upon the organism, the level of their accumulation in organs and tissues, and the specificity and physical and chemical properties of the element itself. Copper most explicitly inhibited the incorporation of radiocarbon from acetate-2-C14 into the albumin synthesized by the liver of carp. Both the level of metal accumulation in the organs and tissues of fish and the retardation influence on the synthesis of albumin in the liver went up with the increase of metal concentration in the water. The overfeeding of fish with Cu triggers certain homeostatic mechanisms which help to excrete the exceeding amounts of metal and to restore the functions of the liver. When the Cu concentration was too high, the death of fish occurred accompanied by forced respiratory movements, disruption in coordination of movements, and turnovers. During the 7-day adaptation of fish to Cu contained in the water in biotic (0.01 mg/l) concentrations, the protein synthesis function and the activating impact of metal on protein synthesis were restored. The toxic effect of Cu is less prominent in the case of lipid synthesis. The increased Cu concentration in water and liver brought about changes in the blood components. Cobalt produced results similar to those obtained with Cu. Mn and Zn did not inhibit the intensity of biosynthesis in the organism and mostly activated the biosynthesis of proteins and lipids. (See also W88-01460) (Geiger-PTT)
W88-01484

EXPERIMENTAL STUDY OF BIOACCUMULATION, TOXICITY AND REGULATION OF SOME TRACE METALS IN VARIOUS ESTUARINE AND COASTAL ORGANISMS,
Nantes Univ. (France). Centre de Dosage des Elements Traces.
For primary bibliographic entry see Field 5C.
W88-01485

UPTAKE AND RELEASE OF MERCURY AND CADMIUM IN VARIOUS ORGANS OF MUSSELS (ANODONTA CYGNEA L.),
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
J. Salanki, and K. V.-Balogh.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 325-340, 12 fig, 3 tab, 16 ref.

Descriptors: *Heavy metals, *Cadmium, *Mercury, *Bioaccumulation, *Mussels, Adsorption, *Path of pollutants, *Water pollution effects, Bioindicators, Monitoring, Mytilus, Biological magnification, Lakes, Kidneys, Muscle, Gills, Tissue analysis.

The uptake and release of Hg and Cd in various organs of the mussel Anodonta cygnea L. were examined under laboratory conditions. Following exposure of mussels to 10 micrograms/l Hg solution, the concentration of Hg increased in all organs within 30-60 min, however, in a few hour it dropped everywhere below the control. Following further exposure an increase started again first in the gills and later in all organs, reaching a moderate elevation by 24 hr. The concentration of Cd increased during the first 24 hr following the exposure of mussels to 16 micrograms/l Cd only in the kidney, which was noticeable already within 1 hr, but it also decreased somewhat between 12 and 24 hr. After exposure for 72, 168, 336, 504, 672, and 840 hr, the uptake of both Hg and Cd increased linearly in most organs. A saturation with Hg in the gills and with Cd in the kidney and viscera were noted. The concentration factor was different for both metals for different organs. Hg taken up with 840 hr was not released in equal degrees from various organs, and there was not total depuration from either of them during the experimental period. Depuration of Hg was fastest from the kidney, the adductor muscle and the mantle. Binding of Cd was in each organ stronger than that of Hg. These results offer a practical guideline for using mussels for monitoring a steady or fluctuating Hg and Cd pollution. (See also W88-01460) (Geiger-PTT)
W88-01486

EXCRETION OF HEAVY METALS BY FISH,
Bezirksinstitut fuer Veterinarwesen Karl-Marx-Stadt (German D.R.).
K. Grahl, P. Franke, and R. Hallebach.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 357-365, 56 ref.

Descriptors: *Heavy metals, *Bioaccumulation, *Excretion, *Fish, *Path of pollutants, *Water pollution effects, Bioindicators, Monitoring, Adsorption, Biotransformation, Toxicity, Kinetics, Liver, Kidneys.

In vertebrates, heavy metals are eliminated predominantly by the kidney and/or by the bile. The excretion via urine is the most important route of excretion in mammals. However, Ag, As, Cd, Cu, Fe, Mn, Pb, Zn, Zr, and organo-heavy metals are excreted mainly through the bile in dependence on

species. Increased concentrations of non-essential heavy metals in urine and bile indicate a contamination caused by the metals in question. The concentration of essential heavy metals in the bile is determined by various factors, e.g. nutrition, stress, intoxication (by orgnaic and inorganic substances), infections. It demonstrates intact or non-intact homeostasis. Considering the specific physiology in the case of essential heavy metals, further studies should test the usability of fish-bile for monitoring environmental toxicants and for detection of sublethal intoxications as far as heavy metals are concerned. (See also W88-01460) (Author's abstract)
W88-01488

BIOCHEMICAL COMPARTMENTATION OF FISH TISSUES, HEAVY METAL TOXICITY ON TISSUE NON-SPECIFIC PHOSPHOMONOESTERASES IN THREE FISHES,
Regional Coll. of Education, Bhopal (India). Dept. of Science.
For primary bibliographic entry see Field 5C.
W88-01489

EFFECT OF CU ON SOME BIOCHEMICAL PARAMETERS OF FISHES,
Jozsef Attila Univ., Szeged (Hungary). Dept. of Biochemistry.
For primary bibliographic entry see Field 5C.
W88-01492

5C. Effects Of Pollution

EFFECTS OF CD AND CU ON A BIOFILM TREATMENT SYSTEM,
Missouri Univ.-Rolla. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W88-00994

ENVIRONMENTAL FEASIBILITY OF USING CREOSOTE CONTAMINATED SOIL AND SLUDGES IN ROADWAY PAVING STRUCTURES,
Alabama Univ., University. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W88-01000

USE OF BIOASSAYS TO DETERMINE POTENTIAL TOXICITY EFFECTS OF ENVIRONMENTAL POLLUTANTS,
Corvallis Environmental Research Lab., OR. Hazardous Waste and Water Branch.
For primary bibliographic entry see Field 7A.
W88-01088

URBAN NONPOINT SOURCE IMPACTS ON A SURFACE WATER SUPPLY,
W. W. Walker.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 129-137, 6 fig, 6 tab, 22 ref.

Descriptors: *Nonpoint pollution sources, *Water pollution effects, *Water supply, *Saint Paul, *Minnesota, Lakes, Nutrients, Urban areas, Limnology, Eutrophication, Runoff, Model studies.

Lake drinking water supplies are particularly vulnerable to nonpoint pollution sources because of cause-effect relationships linking watershed characteristics, nutrient loading, lake eutrophication, treatment plant disturbances, and quality of water supplied to consumers. Results from the first year of an intensive watershed and lake monitoring program undertaken by St. Paul Water Utility, MN, are described. The objectives of the program are: (1) to characterize the limnology of the supply lakes, (2) to quantify major sources of runoff, nutrients, and other pollutants reaching the lakes, and (3) to identify potential control measures for algal-related taste-and-odor problems that have developed in recent years. While diversions from other watersheds account for an average of 85% of the flow through the lakes, runoff and nutrient loadings from local watersheds undergoing rapid urban development have become increasingly important. Site-specific and regional data indicate significant effects of urban land uses on runoff and nutrient export. Linked models relate watershed land uses to lake water quality conditions and Water Utility impacts, expressed in terms of the frequency of nuisance-level algal densities and potential costs of chemicals used for taste-and-odor control. The models are used to estimate the impacts of existing and future urban development in the basin on lake water quality conditions and treatment costs. (See also W88-01083) (Author's abstract)
W88-01107

WHY SCOFIELD RESERVOIR IS EUTROPHIC: EFFECTS OF NONPOINT SOURCE POLLUTANTS ON A WATER SUPPLY RESERVOIR IN UTAH,
Geological Survey, Salt Lake City, UT.
D. Stephens.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 142-146, 4 fig, 2 tab, 10 ref.

Descriptors: *Scofield Reservoir, *Eutrophication, *Water pollution effects, *Nonpoint pollution sources, *Utah, *Reservoirs, Water supply, Nutrients, Trace metals, Algae, Mercury, Phosphates.

Studies since 1979 have classified Scofield Reservoir as mesoeutrophic or eutrophic. The principal pollutants are nutrients, trace metals, and sediments associated with nonpoint sources, such as construction of roads and mine portals, domestic waste disposal, animal grazing, and natural deposits of rock containing phosphate. Blooms of blue-green algae, which have resulted in fishkills, have corresponded to years of decreased inflow. Biota populations during wet years were quite diverse, with only minimal numbers of undesirable blue-green algae. During 1981, however, the minimum usable water storage decreased to 31% of the 25-year average and blue-green algae blooms resulted in serious fishkills. Concentrations of mercury in the water in Scofield Reservoir have caused concern for water users, but none of the concentrations has exceeded revised State standards. The mercury originates from coal particles within the drainage basin, and most of it is bound as silicate in the reservoir sediments and is not readily soluble. Several management practices have been implemented to decrease nonpoint source pollution. Among these are an improved waste disposal station for recreational vehicles, a containerized waste system for fish cleaning, and streambank stabilization. (See also W88-01083) (Author's abstract)
W88-01109

ECONOMICS: NONPOINT SOURCE POLLUTION IMPACTS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6C.
W88-01125

ACCUMULATION OF SEDIMENT, NUTRIENTS, AND CESIUM-137 IN PRAIRIE POTHOLES IN CULTIVATED AND NONCULTIVATED WATERSHEDS,
Fish and Wildlife Service, Yankton, SD.
For primary bibliographic entry see Field 4C.
W88-01134

PHOSPHATE AND PEAT MINING IN FLORIDA,
Saint Johns River Water Management District, Palatka, FL.
For primary bibliographic entry see Field 4C.
W88-01147

WATER QUALITY PROBLEMS CAUSED BY ABANDONED METAL MINES AND TAILINGS,
Missouri Dept. of Natural Resources, Jefferson City.
J. Ford.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 344-345, 1 fig, 2 tab, 10 ref.

Descriptors: *Water quality, *Mine wastes, *Metals, *Water pollution, *Missouri, *Path of pollutants, Lead, Heavy sediments, Zinc, Heavy metals, Environmental effects, Cleanup operations, Sediments.

One active and one inactive lead mining area are located completely within Missouri and a second inactive mining area is shared with Oklahoma and Kansas. Both areas adversely affect streams, contributing both heavy sediment loads from eroding tailings piles and dissolved metals (primarily zinc) from both surface runoff and seepage from flooded mines. Occasional tailings dam failures result in deposition of huge amounts of sand and silt-sized tailings that smother all existing aquatic life and seriously degrade aquatic habitat for years. A total of 58 miles of classified stream is affected. Although removal or proper on-site use of tailings may yet be realized as viable alternatives, stabilization of tailings in place seems the best strategy for reducing nonpoint source problems from tailings in the Old Lead Belt and Fredericktown areas. Planting vegetation on the large flat areas of tailings can control wind erosion. Water erosion control requires good maintenance of the existing internal drains and protection of the dams which are made of sand-sized material. Sediment traps between the tailings and area streams need to be constructed and periodically cleaned. (See also W88-01083) (Lantz-PTT)
W88-01148

HIGHWAY RUNOFF/DRAINAGE IMPACTS,
Federal Highway Administration, McLean, VA.
For primary bibliographic entry see Field 5B.
W88-01158

EVALUATION OF NONPOINT SOURCE IMPACTS ON WATER QUALITY FROM FOREST PRACTICES IN IDAHO: RELATION TO WATER QUALITY STANDARDS,
Idaho Div. of Environment, Boise.
S. B. Bauer.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 455-458, 1 fig, 2 tab, 7 ref.

Descriptors: *Nonpoint pollution sources, *Water pollution effects, *Water quality, *Forestry, *Idaho, *Water quality standards, Fish, Salmon, Economic aspects, Regulations, Logging.

An interdisciplinary task force was appointed by the Board of Health and Welfare to determine the impacts of forest operations on protected uses and make recommendations on water quality standards. Twenty-five forest operations were inspected by the Task Force in 1984 for compliance with the Idaho Forest Practices Act (FPA) and their potential for impacting salmonid fish habitat. Seven of the 25 operations were considered a major impact or hazard to salmonid habitat due to direct delivery of sediment associated with roads or skid trails. At the remaining sites impacts on protected uses were prevented either by site conditions - low geologic hazard, streams with no protected uses - or by good practices. U.S. Forest Service timber sales met or exceeded the Forest Practices Act. Noncompliance on State and private lands was associated primarily with reuse of existing roads near stream channels, failure to identify and use appropriate logging systems in hazardous geologic conditions, and lack of timely installation of erosion control measures. (See also W88-01083) (Author's abstract)
W88-01172

ASSESSMENT OF BLACK ROCK HARBOR DREDGED MATERIAL IMPACTS ON LABORATORY POPULATION RESPONSES,
Environmental Research Lab., Narragansett, RI.

J. H. Gentile, K. J. Scott, S. M. Lussier, and M. S. Redmond.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report D-87-3, July 1987. Final Report. 62 p, 13 fig, 15 tab, 22 ref, 2 append.

Descriptors: *Black Rock Harbor, *Water pollution effects, *Dredging, *Environmental effects, Benthos, Lethal limits, Ampelisca abdita, Mysidopsis bahia, Toxicity, Suspended sediments.

Studies were conducted to determine the applicability of using population responses to assess the impact of dredged material. Laboratory methods were successfully developed to continuously expose Ampelisca abdita and Mysidopsis bahia to bedded and suspended sediments throughout their life cycle. Biological effects, including survival, individual growth, reproduction, and intrinsic rate of population growth, were measured over a range of exposures to Black Rock Harbor dredged material (BRH). Short-term effects (96-hr LC50) were observed at BRH suspended sediment concentrations of 262 mg/L and 80 mg/L for M. bahia and A. abdita, respectively, while the 10-day LC50 for A. abdita was 10.5 mg BRH/L. Thus, A. abdita was three times more sensitive to the acute effects of BRH sediment than M. bahia. Acute toxicity in A. abdita was strongly time dependent with 10-day exposures showing an eightfold increase in toxicity compared to the 4-day toxicity data. This may be the result of A. abdita's more intimate contact with the contaminated sediments. The concentrations of BRH suspended sediments causing effects on growth, reproduction, and population growth to M. bahia were 25, 18, and 8 mg/L, respectively. Ampelisca abdita growth and reproduction were impaired at 2.2 mg/L, and population growth was affected at 1.1. mg/L. This study demonstrates that chronic responses are the best predictors of environmental impacts. The use of population responses is of particular value since populations are the level of biological organization of concern. The application of demographic techniques to life cycle toxicity tests provides an ecological framework for interpreting the significance of chronic toxicity data. (Author's abstract)
W88-01194

SISTER CHROMATID EXCHANGE IN MARINE POLYCHAETES EXPOSED TO BLACK ROCK HARBOR SEDIMENT,
Environmental Research Lab., Narragansett, RI.
G. G. Pesch, C. E. Pesch, A. R. Malcolm, P. F. Rogerson, and G. R. Gardner.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report D-87-5, July 1985. Final Report. 122 p, 29 fig, 9 tab, 87 ref, 2 append.

Descriptors: *Toxicity, *Mutagenicity, *Sister chromatid exchange, *Marine environment, *Polychaetes, *Black Rock Harbor, *Water pollution effects, Environmental effects, Toxicity, Nephtys incisa, Polychlorinated biphenyls, Aromatic compounds, Hydrocarbons, Tissue analysis, Chromium, Benzo-a-pyrene.

The use of sister chromatid exchange (SCE) to measure potential mutagenic activity associated with contaminated dredged material was evaluated. The three primary objectives were to test the applicability of the SCE technique, to field verify any responses observed in the laboratory, and to determine the degree of correlation between the bioaccumulation of contaminants and the SCE response. The SCE technique was applied to Nephtys incisa, an infaunal polychaete dominant in the benthic community at the Central Long Island Sound (CLIS) disposal site. The SCE response was measured in N. incisa exposed to suspended and bedded sediment phases of Black Rock Harbor (BRH) dredged material in the laboratory. The treatment employing suspended BRH sediment over bedded reference sediment was significantly higher than all other treatments. BRH sediment contains high concentrations of many contaminants including polychlorinated biphenyls (PCBs) and polynuclear aromatic hydrocarbons (PAHs) that accumulate in tissues of worms exposed in both the laboratory and the field. Tissue concentrations of PCBs and PAHs in field-collected N. incisa peaked during the summer of 1983 and declined during the fall. Of ten chemicals and two summary statistics analyzed for correlation between SCE response and tissue concentrations, only two, benzyo(a)pyrene (BaP) and chromium, are known mutagens. Chromium can be a direct-acting mutagen, and a correlation between chromium concentration in tissues and SCE response was found (r = 0.83). Because of the multicontaminant nature of the dredged material and the study designs used, potential cause-effect relationships between tissue residues and SCE response were not addressed. The increased SCE frequencies associated with exposure to BRH sediment are indicative of mutagenic activity and underscore the need for genotoxicity testing in evaluating wastes to be disposed in the ocean. (Lantz-PTT)
W88-01195

IMPACT OF OPEN-WATER DISPOSAL OF BLACK ROCK HARBOR DREDGED MATERIAL ON BENTHIC RECOLONIZATION AT THE FVP SITE,
Science Applications International Corp., Narragansett, RI.
J. Scott, D. Rhoads, J. Rosen, S. Pratt, and J. Gentile.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report D-87-4, July 1987. Final Report. 123 p, 30 fig, 11 tab, 58 ref, 2 append.

Descriptors: *Water pollution effects, *Waste disposal, *Black Rock Harbor, *Connecticut, *Dredging, *Benthos, Marine environment, Sediments, Remote Ecological Monitoring of the Seafloor System, Monitoring, Population studies.

The effects of the disposal of dredged Black Rock Harbor (BRH) sediments on the ambient (predisposal) community and the mode and pattern of recolonization at the Field Verification Program (FVP) site were examined. As a result of the disposal operation, a dredged material mound of BRH sediments approximately 1.5 to 2.0 m deep was deposited at the center (CNTR) station. The apron of the mound (depths <10 cm) extended to ca. 200 m in each direction. The species numbers at the 200E station had returned to background levels by December 1983, whereas the recruitment at CNTR was lagging behind what was found at 400E, 1000E, and the reference section (REFS). By mid-1984, species numbers were similar at CNTR and REFS, with a more diverse assemblage present on the mound. The Remote Ecological Monitoring of the Seafloor System (REMOTS) surveys indicated a significant change in the physical properties of the dredged material disposal mound as compared with the surrounding ambient stations and REFS. A sandy surface was found soon after disposal and continued throughout the survey period. The biological mixing depths (BMD) on the mound (CNTR and other mound stations) increased at a rate of 200 to 400 micrometers/day, returned to a unimodal condition, and appeared to converge with the BMD at REFS by January 1984. After this date physical scouring arrested the BMD at the CNTR to levels significantly shallower than those at the REFS station. The Organism-Sediment Index (OSI) over all of the mound stations developed a bimodal frequency distribution that persisted throughout the study period. In addition, OSI values at the disposal site CNTR were consistently lower than at REFS. The FVP site as a whole showed a successional retrograde in Jun 1985, in conjunction with the appearance of black (anoxic) sediment at or near the surface in 80% of the stations surveyed. (Lantz-PTT)
W88-01196

TRACE METALS IN THE ENVIRONMENT: VOLUME 6 - COBALT, AN APPRAISAL OF ENVIRONMENTAL EXPOSURE.
Ann Arbor Science Publishers Inc., Ann Arbor, MI. 1981. 1202 p. Edited by Ivan C. Smith and Bonnie L. Carson.

Descriptors: *Water pollution effects, *Heavy metals, *Cobalt, *Trace metals, *Water pollution sources, Toxicity, Path of pollutants, Drinking water, Environmental effects.

In 1972, the National Institute of Environmental Health Sciences (NIEHS) initiated a program with Midwest Research Institute (MRI) to appraise environmental exposure to specific heavy metals in all their chemical forms and to evaluate the potential environmental and human health effects of the resulting exposures. This book on cobalt is one of a series of comprehensive documents that resulted from this program. It appraises sources of environmental cobalt in all its chemical forms, and evaluates the potential environmental and human health effects of resulting exposure. Specifically, this book identifies natural and anthropogenic sources of cobalt in the environment; evaluates the chemical forms, quantities and modes of transport of cobalt moving through the environment; assesses human exposure to cobalt through inhalation, drinking water, the food chain and dermal contacts; and, finally, assesses the human health hazards expected from these environmental exposures. (See W88-01199 thru W88-01202) (Lantz-PTT)
W88-01198

PHYSIOLOGICAL EFFECTS,
Midwest Research Inst., Kansas City, MO.
B. L. Herndon, R. A. Jacob, and J. McCann.
IN: Trace Metals in the Environment: Volume 6 - Cobalt, An Appraisal of Environmental Exposure. Ann Arbor Science Publishers Inc., Ann Arbor, MI. 1981. p 925-1140, 1 fig, 34 tab, 550 ref.

Descriptors: *Water pollution effects, *Cobalt, *Environmental effects, *Aquatic environment, *Heavy metals, Toxicity, Lethal limits, Fish, Ecological effects.

The toxicity of cobalt and other heavy metals to aquatic wildlife is reviewed. There is a considerable base of information on the lethality and dose effect of cobalt to fish and other aquatic organisms. These studies are summarized in tabular form as the 'Toxicity of Cobalt to Aquatic Species.' The quantitation of stable cobalt levels in aquatic organisms and comparison of these body burdens with the environmental levels have been less well published. (See also W88-01198) (Lantz-PTT)
W88-01202

NATURAL ACIDITY OF WATERS IN PODZOLIZED SOILS AND POTENTIAL IMPACTS FROM ACID PRECIPITATION,
Colorado State Univ., Fort Collins. Dept. of Earth Resources.
For primary bibliographic entry see Field 5B.
W88-01250

INTERNATIONAL ASPECTS OF ACID DEPOSITION,
North Carolina State Univ., Raleigh. School of Forest Resources.
E. B. Cowling.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 429-438, 2 fig, 55 ref.

Descriptors: *Hydrometeorology, *Water pollution effects, *Acid rain, *Air pollution effects, *Environmental effects, Ecological effects, Europe, United States, Industrial wastes, Fallout.

In recent decades, 'acid rain' has become a dominant feature of man induced change in the chemical climate of the Earth. Wherever fossil fuels are burned, metal ores are smelted, and materials are processed on a large scale, various gaseous, aerosol, and particulate waste products are released into the atmosphere. These substances and their reaction products are dispersed by meteorological processes and deposited on vegetation, soils, and surface waters, often at great distances from the source of emissions. Concern has arisen in many countries about effects on forests, fish, crops, water quality, materials, and human health. The result is a growing concern about international exchange of air pollutants, wet and dry deposition of strong acids and other acidifying substances, as well as the associated deposition and mobilization of toxic metals and the leaching of nutrient substances.

These concerns developed originally among the Scandinavian countries, Great Britain and Germany, and other industrial nations of central Europe. More recently they have also developed between Canada and the United States. International cooperation between atmospheric scientists and biologists and among leaders of forestry, agricultural, water resource, industrial, and governmental organizations is resulting in a general concensus about both the phenomena involved and about strategies for the management of acid deposition. (See also W88-01203) (Author's abstract)
W88-01272

U.S. NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM,
National Acid Precipitation Assessment Program, Washington, DC.
C. Bernabo, and R. Herrmann.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 439-441.

Descriptors: *Hydrometeorology, *Acid rain, *National Acid Precipitation Assessment Program, *Interagency cooperation, *Environmental effects, *Water pollution sources, Federal jurisdiction, Regulations.

The National Acid Precipitation Assessment Program (NAPAP) was mandated by Congress (P.L. 96-294) to provide a better understanding of the causes, effects, and options for managing 'acid rain.' The U.S. Interagency Task Force on Acid Precipitation is charged with planning and implementing the National Program. The Task Force integrates and coordinates the diverse federal efforts to establish a firmer scientific basis for formulating energy and environmental policy. Twelve federal agencies participate in the Task Force, which is jointly chaired by USDA, EPA, and NOAA. A 10-year National Plan was issued in June 1982, and it provides a general description of the priorities, objectives, focus, and resources of the program. Nine technical 'task groups' are responsible for developing detailed operational plans for research categories including: natural sources, man-made sources, atmospheric processes, deposition monitoring, aquatic impacts, terrestrial impacts, material effects, control technology, and assessments and policy analysis. The Task Force also coordinates the federal program with the research and monitoring activities of states, universities, private sector groups, and other nations. In conducting the national Program, the Task Force is utilizing various cooperative assessment activities and interdisciplinary analyses of complex regional, national, and international data sets such as those generated by NADP, ILWAS, SNSF, and CANSAP. (See also W88-01203) (Author's abstract)
W88-01273

ACID PRECIPITATION: THE IMPACT ON TWO HEADWATER STREAMS IN SHENADOAH NATIONAL PARK, VIRGINIA,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
P. W. Shaffer, and J. N. Galloway.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 473-483, 5 fig, 3 tab, 23 ref.

Descriptors: *Hydrometeorology, *Acid rain, *Water pollution effects, *Shenandoah National Park, *Virginia, Chemical analysis, Fate of pollutants, Sulfates, Magnesium, Potassium, Cations, Anions, Streams, Temporal distributions, Sodium, Chlorides, Bicarbonates.

The Shenandoah Watershed Acidification Study (SWAS) was initiated in October 1979; the purpose of this study is to evaluate the present and future impact of acid precipitation on soil and stream water chemistry in the Shenandoah National Park. The study focuses on two small watersheds in the park. Weekly precipitation and stream water chemistry sampling has been carried out since November 1979; results for the first two years are presented. Temporal data shows dilute but stable water chemistry except for a modest summer increase in bicarbonate and associated base cations in one of the study streams. Sulfate is the dominant anion, magnesium and potassium the dominant cations. Input-output budgets show that many major cations and anions are accumulating in the watersheds, including H(+), NH4(+), NO3(-), SO4(2-), and Ca(2+), while there is net export of K(+), Mg(2+), HCO3, and silica. Sodium and chloride show net export during periods of high stream discharge, and accumulation during low flow; long term input and output are probably about equal. Stability of stream water chemistry appears to be controlled primarily by sulfate adsorption, bicarbonate production, and cation exchange equilibria in the soil. Because sulfate adsorption capacity is finite and because there is net export of base cations from soil, current stability is achieved at the cost of long term degradation of the soil system. (See also W88-01203) (Author's abstract)
W88-01278

IMPACT OF ATMOSPHERIC DEPOSITION ON THE WATER QUALITY OF EVERGLADES NATIONAL PARK,
Everglades National Park, Homestead, FL.
M. D. Flora, and P. C. Rosendahl.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 485-491, 1 fig, 5 tab, 19 ref.

Descriptors: *Hydrometeorology, *Acid rain, *Water pollution effects, *Everglades National Park, *Water quality, *Marshes, Ammonium, Nitrates, Orthophosphate, Calcium, Sodium, Magnesium, Chlorides, Hydrogen ion concentration, Alkalinity.

A preliminary investigation of the relationship between surface loading and atmospheric deposition indicates that precipitation is responsible for a significant percentage of the chemical constituents entering the unique fresh water marsh system of Everglades National Park. From June 1980 through August 1981, wetfall contributed more than 95% of the ammonium and nitrate and 83% of the orthophosphate entering the 1000 sq km Shark River Slough, the major fresh water drainage of Everglades National Park. Conversely, surface water delivery is responsible for more than 95% of the calcium, sodium, magnesium, and chloride; and more than 85% of the sulfate input into the slough. The mean volume weighted pH of precipitation during this 14-month period was 4.9, which while acidic, is not sufficient to alter the pH of the highly buffered surface water of the slough, which has a mean alkalinity of 182 mg/L (as CaCO3). (See also W88-01203) (Author's abstract)
W88-01279

RED SPRUCE DIEBACK IN VERMONT AND NEW HAMPSHIRE: IS ACID PRECIPITATION A CONTRIBUTING STRESS,
Pennsylvania Univ., Philadelphia. Dept. of Geology.
A. H. Johnson, D. G. Lord, and T. G. Siccama.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 493-497, 4 fig, 5 tab, 18 ref.

Descriptors: *Hydrometeorology, *Red spruce, *Vermont, *New Hampshire, *Acid rain, *Water pollution effects, *New York, Forests, Hydrogen ion concentration, Cloud water, Stress, Environmental effects.

A dieback of red spruce (Picea rubens) has been quantitatively documented in the high elevation boreal forest of Vermont, and observed in New Hampshire and New York. No primary pathogens or obvious abiotic factors appear to be responsible for the dieback. The boreal forest of the Green and White Mountain peaks is above cloud base for extended periods (800-1600 hr/yr), and cloud moisture is very acid (average pH approximately 3.7). A study of foliar, root, and soil chemistry in healthy and declining stands in Vermont and New Hampshire leaves open the possibility of acid rain induced stress due to effects on foliage or, less likely, effects due to high levels of root aluminum. (See also W88-01203) (Author's abstract)
W88-01280

EFFECTS OF AMBIENT CONCENTRATIONS OF AIR POLLUTANTS ON VEGETATION INDIGENOUS TO THE BLUE RIDGE MOUNTAINS OF VIRGINIA,
Pennsylvania State Univ., University Park. Dept. of Plant Pathology.
J. M. Skelly, B. I. Chevone, and Y. S. Yang.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 499-503, 5 tab, 24 ref. Dept. of the Interior Contract No. CX001-9-0011.

Descriptors: *Hydrometeorology, *Water pollution effects, *Acid rain, *Vegetation, *Virginia, *Ozone, *Blue Ridge Mountains, Air pollution, Environmental effects, Biomass, Photochemical oxidants.

Vegetation indigenous to the Shenandoah National Park (SNP) and Blue Ridge Mountains of Virginia has been exposed to phytotoxic concentrations of oxidant air pollution, primarily ozone (O3), over the past several years. Exposure of vegetation to episodic O3 incursions has resulted in visible symptom expression on several native plant species. Longer term, low dosage exposures typically recorded throughout the summer oxidant season have been demonstrated to reduce foliar biomass production of native forbes, grasses, and sedges via an air pollutant exclusion chamber system in the Big Meadows area of the SNP. Seedling height growth of several forest tree species was also adversely affected by ambient oxidant concentrations. Monitoring data for O3 and SO2 at SNP from 1979-1981 have demonstrated that O3 was present in eight-hour (1100-1800 EST) average concentrations of 0.023 to 0.059 ppm O3 during April through September; hourly average SO2 concentrations rarely exceeded 0.006 ppm. Analysis of weekly rainfall samples has also been conducted since November of 1978 with the lowest pH rainfall recorded of 3.39. The average pH of all weekly samples is about 4.35. No effects to vegetation in the Blue Ridge Mountains have been ascribed to acidified rainfall. (See also W88-01203) (Author's abstract)
W88-01281

POTENTIAL FOR ACID PRECIPITATION DAMAGE TO LAKES OF THE SIERRA NEVADA, CALIFORNIA,
California Univ., Berkeley. Lawrence Berkeley Lab.
K. A. Tonnessen, and J. Harte.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 505-508, 3 fig, 1 tab, 10 ref.

Descriptors: *Hydrometeorology, *Acid rain, *Water pollution effects, *Sierra Nevada, *California, *Lakes, Chemical analysis, Hydrogen ion concentration, Alkalinity, Cations, Microcosm experiments, Nitric acid, Simulation analysis, Environmental effects.

Acid precipitation has been measured in many areas of California, including the Sierra Nevada. This region is characterized by high elevation, granite based lakes which may be sensitive to acid inputs. Possible damage to these aquatic systems due to continued acid deposition was investigated during a program of field monitoring and laboratory microcosm experiments. During 1979-1981 Sierra lake water samples were analyzed for pH, alkalinity, and concentrations of major and minor cations. Microcosm systems, established in a controlled laboratory environment using lake water and sediments, were treated with nitric acid and then analyzed for changes in chemical and biological variables. (See also W88-01203) (Author's abstract)
W88-01282

VARIATION IN ECOSYSTEM SENSITIVITY AND RESPONSE TO ANTHROPOGENIC ATMOSPHERIC INPUTS, UPPER GREAT LAKES REGION,
Michigan Technological Univ., Houghton. Dept. of Biological Sciences.
J. R. Stottlemyer.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 509-513, 1 fig, 5 tab, 10 ref.

Descriptors: *Hydrometeorology, *Water pollution effects, *Acid rain, *Great Lakes, *Ecological effects, *Michigan, *Minnesota, Hydrogen ion concentration, Chemical analysis, Fate of pollutants, Environmental effects, Watersheds.

Precipitation throughout the Upper Great Lakes Region is considered to be acidic. Average annual values range from pH 4.4 in lower Michigan to 5.2 in western Minnesota. In the central portion of the region the comparative values for average annual pH has fallen from 6 to 4.6 since 1955. Baseline data are few, but it appears the regional loading of acidity and associated contaminants is increasing. The Lake Superior basin typifies regional ecological diversity with northern hardwood forest and sedimentary bedrock on the south shore and boreal coniferous forests on Precambrian substrates on the north shore. Isle Royale and basin ecosystem studies show that Lake Superior significantly modifies precipitation inputs temporally and spatially. Often > 50% of the annual input is snow. Snowfall can increase 3X with a rise of 100 m above the lake. This results in the heaviest load of atmospheric contaminants in the more sensitive low order watersheds. Hardwood forest canopies seasonally neutralize acid precipitation. Boreal conifer canopies have minimal effect. Glacial till quality appears more important than bedrock composition in determining whether acid precipitation is neutralized by carbonates or basic aluminum salts. The latter case can result in the release of soluble Al. The vulnerability of lakes and streams is known to be dependent on the nature and degree of watershed buffering. Watersheds with northern hardwoods generally have extensive glacial till, and this vegetation/soil interaction suggests that such ecosystems are much more resistant to the direct impacts of acid precipitation than are boreal ecosystems. (See also W88-01203) (Author's abstract)
W88-01283

CHLORODIBENZODIOXINS AND CHLORODIBENZOFURANS: AN OVERVIEW,
Wright State Univ., Dayton, OH. Brehm Lab.
For primary bibliographic entry see Field 5B.
W88-01311

MANAGEMENT OF TOXIC SUBSTANCES IN OUR ECOSYSTEMS: TAMING THE MEDUSA.
For primary bibliographic entry see Field 5B.
W88-01362

ENVIRONMENTAL CARCINOGENS: THE HUMAN PERSPECTIVE,
Ohio State Univ., Columbus. Dept. of Surgery.
N. A. Reiches.
IN: Management of Toxic Substances in Our Ecosystems: Taming the Medusa. Ann Arbor Science, Ann Arbor, MI. 1981. p 19-42, 2 fig, 1 tab, 29 ref.

Descriptors: *Carcinogens, *Toxic wastes, *Hazardous wastes, *Human diseases, *Water pollution effects, *Public health, Drinking water, Diseases, Human pathology, Epidemiology, Water quality, Cancer, Mortality, Risks, Risk evaluation.

The protection of humans from undue exposures to carcinogenic substances, especially low-level and chronic exposures, and the issues in the study of human diseases from the chronic exposure to organic chemical constituents of drinking water are treated both in their historic and contemporary perspectives. The two major approaches to evaluating human risk, animal studies and direct observations on human populations, were detailed and methodologic problems in establishing cause-effect relationships between toxics and disease states are described. A classic epidemiologic model demonstrating the difficulties and the successes of human observational analysis in disease control is advanced. The need for convergence of chemical, toxicologic and epidemiologic evidence is explained. The need for balance between the probabilistic approach of science and the deterministic approach of regulatory agencies is emphasized. (See also W88-01362) (Wood-PTT)
W88-01364

ECOSYSTEMS THEORY AND THE UNEXPECTED: IMPLICATIONS FOR ENVIRONMENTAL TOXICOLOGY,
Oak Ridge National Lab., TN. Environmental Sciences Div.
R. V. O'Neill, and J. B. Waide.
IN: Management of Toxic Substances in Our Ecosystems: Taming the Medusa. Ann Arbor Science, Ann Arbor, MI. 1981. p 43-73, 79 ref.

Descriptors: *Toxic wastes, *Hazardous wastes, *Pollutant identification, *Ecosystems, *Environmental effects, *Toxicity, *Testing procedures, Hazardous materials, Prediction, Ecosystem response, Dynamics, Environmental effects.

In the twentieth century, responses of environmental systems to potentially toxic substances have been frequently misjudged. Chlorinated hydrocarbons, DDT, and mercury are well-known examples of substances that affected ecosystems in unanticipated ways, substantiating the observation that the responses of ecosystems to human intervention are not easily predicted. Much of the existing toxic substance problem has resulted from negligence in application and disposal of toxicants, but part of the problem is also due to a lack of understanding of ecosystem dynamics. Toxicological testing protocols usually involve single-species systems such as rodents or fish, and are designed to provide rapid, unequivocal results. Both this type of toxicological testing and basic research in toxicology, typically focussing on detailed physiological mechanisms involved in the toxic or carcinogenic response, are valuable but provide inappropriate information for predicting effects on entire ecosystems. Suggestions for improved ecosystem analysis including focus on properties, interactive properties, integrative biogeochemical properties, and rate processes as integrative biogeochemical properties of intact test systems are presented. The use of test systems that are excised as intact units from natural environments and are functioning as intact systems is emphasized. (See also W88-01362) (Wood-PTT)
W88-01365

PARADIGMS IN MULTIPLE TOXICITY,
Concordia Univ., Sir George Williams Campus, Montreal (Quebec). Dept. of Biological Sciences.
P. D. Anderson.
IN: Management of Toxic Substances in Our Ecosystems: Taming the Medusa. Ann Arbor Science, Ann Arbor, MI. 1981. p 75-99, 9 fig, 40 ref. NRC Contract No. 031-1042.

Descriptors: *Toxic wastes, *Hazardous wastes, *Combined pollutants, *Toxicity, *Heavy metals, *Metal mixtures, *Metals, *Multiple toxicity, *Path of pollutants, Hazardous materials, Pollutants, Chemical reactions.

Because chemical pollutants rarely exist singly in the environment, adverse effects which would not have occurred to the same degree with a single chemical were studied. Toxicity response patterns attributable to physiological interactions among two or more substances are classified as multiple toxicity. The additive paradigms in multiple toxicity including concentration addition, response addition, and nonadditive forms of multiple toxicity are reviewed and several examples of multiple toxicity patterns arising from binary mixtures of heavy metals are presented. Some heavy metal combinations appear to be additive (Cd-Zn), many are supraadditive (Cu-Ni, Cu-Cd, Cd-Hg, and Cu-Zn), and one is infraadditive (Ni-V). The evidence also suggests that the toxicity pattern of a metal mixture is influenced by water hardness, relative proportion of constituents in the mixture, and duration of exposure. Hazardous forms of multiple toxicity appear to be common to many metal mixtures though it is difficult to predict the magnitude and type of response. (See also W88-01362) (Wood-PTT)
W88-01366

HAZARDOUS WASTE DISPOSAL: ASSESSING THE PROBLEM.
For primary bibliographic entry see Field 5E.
W88-01375

LESSON OF LOVE CANAL,
New York State Dept. of Health, Albany. Div. of Labs. and Research.
C. S. Kim.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 10-13.

Descriptors: *Toxic wastes, *Water pollution effects, *Love Canal, *Waste disposal, *Hazardous wastes, *Landfills, *Public health, *Path of pollutants, Leaching, Environmental effects, Monitoring, Air pollution, Epidemiology, Land disposal, Waste management, Human diseases, Radiation, Soil contamination.

In the spring of 1978, the New York State Health Department issued a public advisory to Niagara County officials, alerting them that the people living adjacent to the Love Canal inactive landfill were being exposed to chemicals in concentrations that could pose a hazard to their health. This advisory set in motion a continuing series of health and environmental studies of the people, soil, air, and water of the Love Canal neighborhood. Environmental sampling established the presence of a host of toxic chemicals in the landfill, including dioxin; a history of outward migration of at least some of these chemicals principally through porous topsoil and drainage pipes; generally diminishing degrees of soil and air contamination as one moves further away from the landfill; and varying gradients of human exposure to toxic chemicals. Epidemiological and health testing at the Love Canal showed no increased incidence of cancer or other diseases; however, an increased incidence of spontaneous abortions and/or low birthweight babies occurred some years ago in certain sections of the Love Canal area. (See also W88-01375) (Geiger-PTT)
W88-01376

ASSESSING THE PROBLEM -- LOVE CANAL,
Roswell Park Memorial Inst., Buffalo, NY. Dept. of Molecular Biology.
B. Paigen.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 14-29, 5 fig, 3 tab, 7 ref.

Descriptors: *Water pollution effects, *Love Canal, *Public health, *Hazardous wastes, *Waste disposal, *Environmental effects, *Landfills, Surveys, Epidemiology, Waste dumps, Toxicity, Waste management, Leaching, Soil contamination.

In response to an increased incidence of miscarriages in women living in the area of the Love Canal landfill, the New York State Department of Health conducted a health survey of the surrounding community in 1978. The local community found the conclusions of this survey to be at variance with their own experiences and therefore a second survey was carried out using an internal control and only health effects that were diagnosed by a physician. Results of the survey showed a three-fold increase in fetal deaths in pregnant women who live in wet homes compared to those who lived in dry homes. Asthma ws 3.5 times as likely to occur in wet homes as in dry homes. Urinary tract disease was 2.8 times more frequent in wet homes. The organ systems that appeared to be most affected in Love Canal residents were the central nervous system, respiratory system, urinary system, and fetal toxicity. Several factors in the survey contribued a bias toward underestimating the effects of chemical exposure at Love Canal.

Geographical clustering can be demonstrated when the various health problems are combined into a single map. Due to the confusion of political interests in the Love Canal studies, the true extent of the health hazards experienced by the resident of Love Canal is not known. (See also W88-01375) (Geiger-PTT)
W88-01377

ASSESSMENT OF THE CHURCH ROCK URANIUM MILL TAILINGS SPILL: A STRATEGY FOR EVALUATING HEALTH RISKS FROM NUCLEAR FUEL CYCLE ACCIDENTS,
Centers for Disease Control, Atlanta, GA.
A. J. Ruttenber, and K. Kreiss.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 44-58, 2 tab, 15 ref.

Descriptors: *Public health, *Hazardous wastes, *Uranium, *Waste disposal, *Radioactive wastes, Water pollution effects, Path of pollutants, Monitoring, Drinking water, Groundwater pollution, Environmental effects, Epidemiology, Cleanup.

On July 16, 1979, there was a break in an earthen tailings pond retaining dam at the United Nuclear Corporations's Church Rock Uranium Mill which allowed acidified effluent and tailings slurry to contaminate the Rio Puerco river system. Health effects assessment involved identifying the toxic substance in the tailings, collecting environmental samples to determine human exposure routes to radionuclides, and testing animals and humans for possible exposure to radionuclides in the U238 series. Results showed some contamination of groundwater supplies and soil and high levels of radionuclides in animal tissues. The six Navajos chosen for in vivo analysis showed normal levels of activity upon radiometric analyses. The Church Rock spill demonstrates the importance of a thorough analysis of pre-operational background radionuclide concentrations in the river water, food chain, and soil. Post accident health assessments should include a complete description of monitoring results and assessment of data quality, and define the relationship between low dose radiation and health risks. The use of cancer registries for small populations of exposed individuals is discussed. (See also W88-01375) (Geiger-PTT)
W88-01380

LATHROP, CALIFORNIA: ASSESSING THE PROBLEM,
California Dept. of Health Services, Berkeley. Hazardous Materials Lab. Section.
R. D. Stephens.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 61-67, 1 tab, 1 ref.

Descriptors: *Hazardous wastes, *Path of pollutants, *Pesticides, *Waste disposal, *Public health, *Groundwater pollution, *Soil contamination, Environmental effects, Hazardous materials, Monitoring, Organophosphorous compounds, Chlorinated hydrocarbons, Water pollution sources.

Following reports of sterility in male workers at the Occidental Chemical Company, the U. S. Environmental Protection agency and the State of California launched an audit investigation of the company's operations to be used in developing a plan of study to determine the extent of groundwater/soil contamination in the area. Major findings of this audit uncovered the percolation of sulfate ions and radioisotopes into local groundwater, discharge of ammonium ions to unlined ponds, onsite burial of vanadium pentoxide causing soil contamination, and pesticide disposal into unlined ditches and ponds in permeable soil areas. A detailed study plan was designed to determine the full areal extent of chemical and radiological contamination resulting from operations at Occidental, establish an appropriate long term monitoring program to measure migration of materials, determine appropriate mitigation measures to prevent adverse public health and environmental impacts, and determine the effectiveness of mitigative measures. Although all the data are not yet in and considerable interpretation is still required, the state of knowledge about the problems at Lathrop has advanced to a considerable degree. The preliminary findings of this investigation indicate that probably the full extent of the impacts of operations at the Lathrop facility has not been determined. (See also W88-01375) (Geiger- PTT)
W88-01381

REPORT ON CMA'S INVESTIGATION OF THE LIPARI LANDFILL,
Chemical Manufacturers Association, Washington, DC.
W. H. Harrington.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 102-112, 2 fig, 2 tab.

Descriptors: *Path of pollutants, *Landfills, *Hazardous wastes, *Waste disposal, *Groundwater pollution, *Leaching, Monitoring, Water quality, Public health, Aquifers, Soil contamination, Leachates.

The results of the Chemical Manufacturers Association (CMA) evaluation of the Lipari Landfill, near Pitman, New Jersey are presented. Analytical data show significant concentrations of several chemicals in the leachate. The leachate is toxic to fish. Air quality is satisfactory. Surface waters of Rabbit Run, Chestnut Branch, and Alcyon Lake appear to be contaminated with significant levels of bis2-chloroethyl ether. Drinking water wells are not contaminated by leachate from the landfill, however, the chemical quality of deep aquifers is unknown. The nature of the soil on the top and sides of the landfill permits a relatively free movement of water into and through the site, thereby continually generating contaminated leachate. High levels of human traffic onto the site carry significant chemical exposure potential. CMA concluded that there is no threat to human health from the leachate, but a groundwater monitoring program should be instituted. It was recommended that the landfill be fenced to keep people out, and a study be made to determine the need for leachate collection and treatment. (See also W88-01375) (Geiger-PTT)
W88-01385

PERIPHERAL NERVE DAMAGE IN AFFECTED POPULATIONS,
State Univ. of New York at Buffalo, Amherst.
S. Barron.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 113-120, 2 fig, 2 tab.

Descriptors: *Toxic wastes, *Water pollution effects, *Public health, *Landfills, *Toxicity, *Human pathology, *Waste disposal, *Hazardous wastes, Epidemiology, Case studies, Waste dumps.

Studies were conducted of the neurotoxic effects on exposed populations of the hazardous materials in the Love Canal landfill in New York. Although there was no significant difference between the Love Canal population and the control popualtion, the failure to reach statistical significance should not preclude the possilbility of a real biological effect on nerve conductance due to exposure to the chemicals. In an attempt to validate whether the observation of the sural and ulnar conduction velocity was a real observation, a second study was undertaken on a population of 158 children, about half from the Love Canal area and the other half controls. Again, no significant difference in the two measures made between the two groups was found. Several problems are noted in the study of industrial environmental contamination by dump sites. Combinations of toxicants whose composition and proportions are unknown are encountered. The neurotoxicants are heterogeneously distributed within the dump site and a person living on or near a highly contaminated area would likely have more of an adverse health effect than people living in a slightly contaminated area. There is a possible synergism of actions that diminish the usefulness of data derived from single toxicant models of exposure. There is difficulty in predicting which physiologic measures will be the most appropriate and in establishing the levels of exposure and the dose-response relationship. Finally, there is a social and political ambiance that interferes with clinical investigations, or at least interferes with the timely performance of such studies. (See also W88-01375) (Geiger-PTT)
W88-01386

CENTERS FOR DISEASE CONTROL'S HUMAN HEALTH ASSESSMENT APPROACH INVOLVING IMPROPERLY DISPOSED CHEMICAL WASTE,
Centers for Disease Control, Atlanta, GA.
R. D. Kimbrough.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 121-130, 1 fig, 1 tab, 12 ref.

Descriptors: *Toxic wastes, *Waste disposal, *Public health, *Human diseases, *Environmental effects, *Water pollution effects, *Hazardous wastes, Toxicity, Bioassay, Ecological effects, Fate of pollutants, Human pathology.

The Center for Disease Control approach to health assessments involving improperly disposed chemical wastes seeks to determine the nature of the problem in terms of acute, or chronic exposure, single or multiple chemicals, and the size of the population affected. A decision is made as to which tests and/or studies are useful in a particular situation and whether and what type of epidemiological study should be performed. Epidemiology studies in which laboratroy data are generated are designed jointly with the laboratory. Designs of epidemiological studies include procedures to be used for data handling. The effects of chemical exposure in sub-populations that may be more vulnerable, such as infants, the infirm, the elderly, or the improperly nourished are assessed. Independent of specific problems, guidelines are developed for special studies that will then be ready for use when indicated. Special laboratory tests and laboratroy backup of field studies are developed, particularly in the area of quality control and assurance, and the development of micromethods. New methods and the modification of available methods for the detection of exogenous chemicals in biological specimens and for the detection of effects of such chemicals in biological systems are developed. Radioimmunoassays and tissue culture sytems are developed as screening tools for the detection of chemicals and clinical effects in humans, such as allergic reactions, changes in DNA and other biological substances. The effects of chemical exposure on nutrients, such as Vitamin C blood levels and trace elements are assessed. Whether all or some of these goals will be reached will depend on the amount of funding available for this endeavor. (Geiger-PTT)
W88-01387

PUBLIC HEALTH IMPLICATIONS OF ILLEGAL DUMPING OF TOXIC WASTES,
Health and Hospitals of the City of Boston, Inc., MA.
J. Valentine, G. A. Lamb, A. Plough, D. M. Ozonoff, and M. Perkins.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 131-146, 6 fig, 5 tab.

Descriptors: *Toxic wastes, *Public health, *Waste disposal, *Hazardous wastes, *Toxicity, *Water pollution effects, Fate of pollutants, Human pathology, Human diseases, Epidemiology, Waste dumps, Environmental effects, Ecological effects.

Untreated toxic wastes were illegally stored on a parcel of land in a mixed residential-industrial neighborhood in Boston between 1978 and 1979. Community residents requested that the Department of Health and Hospitals assess the possible health effects of exposure to substances on the site. The site was cleaned up by December 1979, while in September 1979, a study was conducted to determine the short-term and potential long-term health impact on community residents. A random sample of households was drawn from within each of three concentric rings drawn around the dumpsite. Residents were interviewed about conditions

and incidences of pneumonia, bronchitis, heart failure, shortness of breath, eye infection, skin infection, headache, and fatigue, as well as any other significant medical conditions. Results showed that reports of health problems are greater in either Circle I or II, as compared to Circle III (the farthest from the dumpsite). Two conditions were significantly related to distance from the dumpsite with Circle II the highest in both cases. An index of risk for respiratory problems was developed which could take into account past medical problems. Low birthweight rates in census tracts for the two exposure years were not significantly different from the city-wide rates based on simple chi-square tests, but were much higher than the statewide rates. (See also W88-01375) (Geiger-PTT)
W88-01388

METHODS FOR ASSESSING HEALTH RISKS IN POPULATIONS LIVING NEAR HAZARDOUS WASTE SITES,
Roswell Park Memorial Inst., Buffalo, NY.
B. Paigen, and J. H. Highland.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 147-160, 2 fig, 1 tab, 16 ref.

Descriptors: *Toxic wastes, *Public health, *Toxicity, *Hazardous wastes, *Bioassay, *Waste disposal, Monitoring, Environmental effects, Ecological effects, Surveys, Human diseases, Models, Carcinogens, Epidemiology, Human pathology, Testing procedures.

The Love canal population has provided a testing ground for the problem of assessing health risk in populations living near hazardous waste sites. Several methodologies are suggested as alternatives to the use of health surveys. Detailed chemical analysis of the site has limited utility and is often very expensive. Three different populations of animal surrogates could be examined for health effects: household pets, laboratory animals raised in homes or exposed to contaminated water or soil in the laboratory, and indigenous wildlife. Surveys of adverse pregnancy outcomes are useful in sampling a relatively short period of time so that the time between chemical exposure and adverse health impact is short. The growth of children might be an important early warning system for chemical toxicity. Tests of nerve function might provide a useful tool in monitoring health effects because many hazardous wastes sites contain chemical neurotoxins. Tests in other organ systems include blood sampling, chromosomal abberations, sperm abnormalities, DNA strand breaks, unscheduled DNA synthesis, altered hemoglobin in red blood cells, altered lactate dehydrogenase in sperm, and mutagenic activity in blood and urine. (See also W88-01375) (Geiger-PTT)
W88-01389

EFFECTS OF ENVIRONMENTAL POLLUTANTS ON ENAMEL HYPOPLASIA AND DENTAL ATTRITION,
Meharry Medical Coll., Nashville, TN. School of Dentistry.
E. Daniels, and M. P. Snead.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 161-172, 5 fig, 2 tab, 12 ref.

Descriptors: *Water pollution effects, *Waste disposal, *Pesticides, *Hazardous wastes, *Toxic wastes, *Public health, *DDT, Polychlorinated biphenyls, Dieldrin, Heptachlor, Chlorinated hydrocarbons, Organic compounds, Environmental effects, Ecological effects, Human diseases, Human pathology, Epidemiology.

The populace of Triana, Alabama is known to be heavilty contaminated with DDT and PCB. Examination of all of the 3 to 5 yr olds in the Triana Day Care Center revealed enamel hypoplasia on the labial surfaces of the anterior teeth in 73% of the children. The canine was one of the affected teeth in 50% of the 22 children examined. In Frayser (Memphis), Tennessee 18 children from eleven different families were examined. The children ranged in age from 3 to 12 years old and had lived in the Frayser neighborhood for three or more years. Enamel hypomineralization was found in 80% and attrition with exposure of dentin in 33%. Some of the chemicals found in the blood of three of the children were DDT, dieldrin, heptachlor and tri-2-butoxyethyl phosphate. (See also W88-01375) (Author's abstract)
W88-01390

PROTECTING THE WORKER: AN OVERVIEW OF THE PROBLEM,
American Federation of Labor and Congress of Industrial Organizations, Washington, DC.
For primary bibliographic entry see Field 5G.
W88-01391

OCCUPATIONAL EXPOSURE MONITORING OF WORKERS AT HAZARDOUS WASTE SITES,
National Inst. for Occupational Safety and Health, Cincinnati, OH. Health Hazard and Technical Assistance Branch.
R. Costello, and J. R. Kominsky.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 179-184, 7 fig.

Descriptors: *Monitoring, *Waste dumps, *Personnel, *Safety, *Water pollution effects, *Hazardous wastes, *Toxicity, Waste disposal, Cleanup, Landfills, Environmental effects, Ecological effects, Testing procedures, Sampling, Human pathology.

NIOSH, the EPA, and the Occupational Safety and Health Administration (OSHA) have monitored exposures to chemical and physical agents received by workers employed at hazardous waste sites. Environmental evaluations have shown parts per billion levels of toxic compounds such as 2,3,7,8-tetrachlorodibenzo-p-dioxin. Mirex and lindane were present in dust samples taken from factories such as the one next to the Hyde Park landfill. EPA has recently developed a draft document for initial reconnaissance acitivites into abondoned dump sites which serves as intermim guidance for worker safety during cleanup operations. Two independent strategies have been employed to monitor hazardous waste sites for inhalation hazards. One of these is the quantification of marker compounds determined by correlating the relative toxicity of substances known to be present with their analytical detectability. The other method is to quantitate to very low concentrations materials of relatively low toxicity and use these materials as tracers of the flow of materials from the site. Quantification is even more difficult when dealing with acute inhalation of hazardous vapors and particulates. There are a number of direct-reading instruments, however, the correct calibration of these instruments to account for interfering substances is often difficult. Protective clothing is often inadequate and may cause heat stress in some workers. Improper use of respiratory protective equipment is probably the cause of most of the acute hazardous waste site accidents. (See also W88-01375) (Geiger-PTT)
W88-01392

MEDICAL SCREENING OF WORKERS AT HAZARDOUS WASTE DISPOSAL SITES,
National Inst. for Occupational Safety and Health, Cincinnati, OH. Health Hazard and Technical Assistance Branch.
J. M. Melius, and W. Halperin.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 185-187.

Descriptors: *Safety, *Personnel, *Waste dumps, *Hazardous materials, *Protection, *Toxicity, Waste disposal, Monitoring, Water pollution effects, Cleanup, Environmental effects.

An appropriately designed and implemented medical program for workers at hazardous waste disposal sites is best considered in the context of other steps which must be taken to protect the health of workers. Engineering controls are valuable to design special equipment for handling large chemical drums, or other special waste handling situations. Industrial hygiene monitoring will play a limited but important role in controlling hazards at these sites. Proper work practices and proper utilization of personal protective equipment are the major methods to protect workers at hazardous waste sites. Biological monitoring should accompany the use of respirators and personal protective equipment, especially when dealing with chemicals that may be absorbed through the skin. Medical screening is best applied where medical tests are available to quickly and easily identify potential adverse health effects. Medical programs must be integrated into an overall program for safety procedures and practices at the site. NIOSH currently has several projects to evaluate the health and safety protection afforded workers at chemical waste sites. More research needs to be done to develop industrial hydiene and medical programs to assure the health and safety of the growing number of workers at chemical waste disposal sites. (See also W88-01375) (Geiger-PTT)
W88-01393

TOXIC WASTE PROBLEMS – THE RESPONSE CAPACITY OF THE MEDICAL COMMUNITY,
Wayne State Univ., Detroit, MI.
For primary bibliographic entry see Field 5E.
W88-01397

EMERGENCY RESPONSE AND PUBLIC HEALTH AT HAZARDOUS WASTE SITES,
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 5G.
W88-01398

MAIN PRINCIPLES OF THE METHODS IN DEFINING THE ECONOMIC EFFICIENCY OF MEASURES FOR PRESERVING UNDERGROUND WATERS FROM NITRATE POLLUTION AT FERTILIZATION,
For primary bibliographic entry see Field 5B.
W88-01405

HEAVY METALS IN WATER ORGANISMS.
For primary bibliographic entry see Field 5B.
W88-01460

UPTAKE OF SELECTED HEAVY METALS BY THE GREEN ALGA CLADOPHORA GLOMERATA,
Polytechnic of Central London (England). Applied Ecology Research Group.
For primary bibliographic entry see Field 5B.
W88-01461

HEAVY METAL ACCUMULATION AND PHYSIOLOGICAL EFFECTS ON AUSTRIAN MACROPHYTES,
Vienna Univ. (Austria). Inst. fuer Pflanzenphysiologie.
For primary bibliographic entry see Field 5B.
W88-01462

DISTRIBUTION OF HEAVY METALS IN AQUATIC MACROPHYTES FROM OKEFENOKEE SWAMP,
Louisville Univ., KY. Systems Science Inst.
For primary bibliographic entry see Field 5B.
W88-01463

HEAVY METAL CONTENT IN MACROPHYTES FROM PONDS SUPPLIED WITH POST-SEWAGE WATER,
Warsaw Univ. (Poland). Dept. of Hydrobiology.
For primary bibliographic entry see Field 5B.
W88-01464

ACCUMULATION, TOXICITY AND LOCALIZATION OF LEAD IN CRYPTOGAMS: EXPERIMENTAL RESULTS,
Hamburg Univ. (Germany, F.R.). Inst. fuer Allgemeine Botanik.

For primary bibliographic entry see Field 5B.
W88-01465

HEAVY METALS AND MINERAL NUTRIENT BUDGET IN PHRAGMITES AUSTRALIS AND TYPHA ANGUSTIFOLIA,
Polish Academy of Sciences, Mikolajki. Inst. of Ecology.
For primary bibliographic entry see Field 5B.
W88-01466

CONCENTRATION OF MICROELEMENTS IN THE AQUATIC WEEDS OF LAKE BALATON,
University of Agriculture, Godollo (Hungary). Dept. of Botany and Plant Physiology.
For primary bibliographic entry see Field 5B.
W88-01467

LEAD IN A PELAGIC FOOD CHAIN,
Moss Landing Marine Labs., CA.
For primary bibliographic entry see Field 5B.
W88-01468

HEAVY METAL CONTENT OF THE FISHES OF LAKE BALATON, DANUBE AND TISZA DURING THE PERIOD OF 1979-1982,
Magyar Tudomanyos Akademia Talajtani es Agrokemiai Kutatointezete, Budapest.
For primary bibliographic entry see Field 5B.
W88-01469

ACCUMULATION OF HEAVY METALS IN AQUATIC ORGANISMS OF SEWAGE WATER TREATMENT PLANTS,
Hajdu-Bihar County Water Canalization Works, Debrecen (Hungary).
For primary bibliographic entry see Field 5B.
W88-01470

ACCUMULATION AND EFFECT OF HEAVY METALS IN THE FISHES OF LAKE BALATON,
Orszagos Allategeszsegugyi Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 5B.
W88-01471

SEASONAL AND LOCAL VARIATION IN THE HEAVY METAL CONCENTRATION IN ANIMALS OF LAKE BALATON,
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
For primary bibliographic entry see Field 5B.
W88-01472

HEAVY METALS IN MARINE ORGANISMS,
Akademiya Nauk Latviiskoi SSR, Riga. Inst. of Biology.
For primary bibliographic entry see Field 5B.
W88-01473

FREQUENCY OF BACTERIA RESISTANT TO HEAVY METALS IN PONDS OF SOUTHERN BOHEMIA,
Ceskoslovenska Akademie Ved, Prague. Ustav Krajinne Ekologie.
V. Riha, and K. Nymburska.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 155-167, 7 tab, 10 ref.

Descriptors: *Heavy metals, *Aquatic bacteria, *Mercury, *Resistance, *Water pollution effects, Lake sediments, Aquatic plants, Lakes, Farm wastes, Toxicity, Water pollution sources, Ponds.

The frequency of aerobic, mesophilic, heterotrophic bacteria resistant to Hg in various samples of freshwater ecosystems (wastewater, water of ponds, sediment, and water plants) from the pond area in South Bohemia was compared. The study area of three ponds (Sofl, Zdenka, and Cap) was relatively free of industrial wastes and contaminated mainly by farm wastes from a duck farm. For comparison, the pond Cerna, located in the forest territory in the vicinity of the system investigated was also studied. Results showed that in the pond-waters 0.64 to 26% of the bacteria were resistant to the Hg concentration 2 micrograms/ml. Bacteria resistant up to the concentration 20 micrograms/ml were found only in the pond Sofl, in its waste waters. In the other ponds of the main system the limit of resistance did not exceed 15 micrograms/ml Hg concentration in the nutrient medium. In the ponds of the diluting system and in the pond Cerna, resistant bacteria were found up to 2 to 10 micrograms Hg/ml. In the sediments 3.96-94.1% bacteria resistant to 2 micrograms Hg/ml were ascertained. In the wastewater of the pond Sofl, bacteria occurred resistant even to 20 micrograms Hg/ml. Bacteria resistant to 100 micrograms Hg/ml were found in the sediment at places where the contaminated waters of the pond Zdenka enter the pond Cap. In the duckweeds 0.13-26.6% bacteria resistant to 2 micrograms Hg/ml were found. The highest Hg concentration to which bacteria were resistant was 20 micrograms/ml in almost all of the plants examined. The concentration of Hg in the water phase was very low (0.02-0.16 micrograms Hg/liter of water). The highest frequency of resistant bacteria was found in the species Elodea (51.6%). The role of epiphytic bacteria in the process of accumulation and transformation of heavy metals is unknown. (See also W88-01460) (Geiger-PTT)
W88-01474

TOTAL MERCURY CONTENT IN THE COMPONENTS OF RUNNING WATER, RESERVOIR AND POND ECOSYSTEMS IN CZECHOSLOVAKIA,
Vyzkumnmy Ustav Rybarsky Vodnany (Czechoslovakia).
For primary bibliographic entry see Field 5B.
W88-01475

BIOINDICATORS FOR THE HEAVY METAL LOAD OF RIVER ECOSYSTEMS,
Bayerische Landesanstalt fuer Wasserforschung, Munich (Germany, F.R.).
For primary bibliographic entry see Field 5A.
W88-01476

HEAVY METAL AND RADIONUCLIDE TRANSFER AND TRANSPORT BY MARINE ORGANISMS,
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
For primary bibliographic entry see Field 5B.
W88-01477

COMBINED EFFECT OF MERCURY AND CADMIUM ON PLANKTON IN SITU,
Akademiya Nauk Latviiskoi SSR, Riga. Inst. of Biology.
Z. Seisuma, I. Kulikova, E. Boikova, S. Marcinkevica, and A. Dzerve.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 207-218, 5 fig, 11 ref.

Descriptors: *Mercury, *Cadmium, *Plankton, *Water pollution effects, *Bioaccumulation, Heavy metals, Phytoplankton, Algae, Aquatic Bacteria, Mathematical studies, Copepods, Zooplankton, Protozoa, Pigments, Synergistic effects, Environmental effects.

Complex investigations on the combined activity of Hg and Cd on unicellular species, zooplankton, bacterioplankton, and phytoplankton and on the pigment composition of phytoplankton were carried out in the Gulf of Riga in experimental ecosystems. Nine experimental bags were taken simultaneously with a single adding of Hg and Cd. During the whole experimental period of 14 days, there were no great changes in the total number of zooplankton in the control bag from the number ocurring in the sea. Shortly after the addition of Hg and Cd, there was a stimulation in zooplankton reproduction followed by a depression. When studying the combined effects of Hg and Cd a domination of copepods Eurytemora sp. of various ages was observed in the control and the experimental bags of different metal concentrations from the beginning of the experiment to the 4th day. High toxicity of Hg was observed on the first day in unicellulars; the effect of Cd appeared to be less toxic than that of Hg. The combined effect of Cd and Hg caused lethal effects in 4 bags of unicellulars. During the first 8 days of the experiment, the number of phytoplankton cells decreased under both concentrations of Hg (10 and 50 micrograms/liter). During the following days, diatom algae increased. The development of phytoplankton was affected little by the Cd concentrations applied. During the 4th to 8th day, the algal chlorophyll a decreased in the controls while in the experimental bags with Hg or Hg and Cd combined, the level of pigment increased. The total number of bacteria in experimental bags with Hg showed almost no changes during the 14 days, while in the experimental bags wtih Cd, a fall in the total number of bacteria was observed. Combined the metals caused an overall increase in the number of bacteria in the bags as compared to controls. (See also W88-01460) (Geiger-PTT)
W88-01478

SOME PROBLEMS OF POLLUTION WITH HEAVY METALS UNDER THE ENVIRONMENTAL CONDITIONS OF THE BALTIC SEA,
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
H. Theede.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 223-237, 5 fig, 1 tab, 41 ref.

Descriptors: *Heavy metals, *Baltic Sea, *Monitoring, *Invertebrates, *Path of pollutants, *Bioindicators, *Water pollution effects, Bioaccumulation, Environmental effects, Salinity, Water temperature, Toxicity, Copper, Cadmium, Mollusks, Ecological effects, Polychaetes, Mytilus.

Experimental studies with marine invertebrates from the Western Baltic Sea indicate that accumulation as well as lethal and sublethal effects of heavy metals may be strongly modified by changes in environmental conditions. Modifying influences of temperature and salinity on the effects of Cd are demonstrated with hydroid polyps and with trochophora larvae of Mytilus edulis. Effects of low oxygen content on the toxicity of copper are reported for a sensitive polychaete and a resistant bivalve species. The last mentioned responds to low copper concentrations in combination with reduced O2-content with an increased energy demand. For the purpose of improving biological content monitoring, it is suggested to relate body burdens of pollutants with long biological half lives to the weight of the calcareous shell of bivalves. Results of monitoring of bioavailable Cd by Cd/shell-wt index of Mytilus edulis from Kiel Fjord exemplify the advantages. (See also W88-01460) (Author's abstract)
W88-01479

GONADOTOXIC AND EMBRYOTOXIC EFFECTS OF CADMIUM IN SEA URCHINS,
Akademiya Nauk SSSR, Vladivostok. Inst. Biologii Morya.
S. M. Gnezdilova, N. K. Khristoforova, and I. G. Lipina.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 239-251, 6 fig, 3 tab, 8 ref.

Descriptors: *Cadmium, *Echinoderms, *Toxicity, *Water pollution effects, *Bioaccumulation, Histology, Heavy metals, Marine animals, Embryonic growth stage, Mortality, Bioindicators, Tissue analysis.

Results of five years of research on the influence of Cd upon reproduction in sea urchins (Strongylocentrotus intermedius) are reviewed. Maximal number of anomalies and highest mortality were registered in the moment of transformation of embryos to larvae. At high Cd concentrations in the

medium (5 and 2.5 mg/l) mass extinction of plutei occurred. At concentrations of 0.5 mg/l, two thirds of embryos developed to normal plutei. The concentration of 5 micrograms/l did not affect the development of fertilized egg cells. Embryogenesis of sea urchins under Cd stress was found to depend on both concentration of toxic matter and on the initial state of sex products. The greatest amount of Cd was accumulated in the intestine of the adult sea urchin. In females, after 10 days of exposure to 0.1, 0.5, and 1.0 mg Cd/l, concentrations of Cd were found to be 16.0, 281 and 323 micrograms/g of dry matter, respectively, while control animals contained only 3 micrograms Cd/g. During three decades, Cd concentration in the intestine of test animals increased 1.5-3 times. The intestine accumulated greater Cd amounts than gonads did, and male individuals accumulated more than females. Histological investigations of sea urchins exposed to high Cd concentrations (> or = 1 mg/l) showed that many growing ovocytes and ripe egg cells underwent resorption. Electron microscopic examination of ovocytes showed many cellular abnormalities in test animals which could result in the development of anomalous offspring. (See also W88-01460) (Geiger-PTT)
W88-01480

INFLUENCE OF SIZE UPON THE CONCENTRATIONS OF CD, CR, CU, HG, PB AND ZN IN THE COMMON MUSSEL (MYTILUS EDULIS L.),
Aarhus Univ. (Denmark). Botanical Inst.
H. Brix, and J. E. Lyngby.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 253-269, 2 fig, 5 tab, 32 ref.

Descriptors: *Heavy metals, *Bioaccumulation, *Mussels, *Bioindicators, *Mytilus, *Path of pollutants, Monitoring, Cadmium, Chromium, Copper, Mercury, Lead, Zinc, Environmental effects, Tissue analysis.

The effect of mussel size upon the concentrations of Cd, Cr, Cu, Hg, Pb, and Zn in the soft tissues and shells of the common mussel (Mytilus edulis L) was investigated. The mean concentrations of the metals in the mussels decreased in the order: Zn > Pb > Cu > Cr > Cd > Hg. On a dry weight basis the concentration levels of all metals were significantly greater in the soft tissues than in the shells. The results of the present investigation suggest that shells of Mytilus edulis are of no practical use in the monitoring of the metals investigated. Three different kinds of relationships between metal concentration and mussel size (soft tissue weight) were recorded: the concentration of Cr in the soft tissue and those of Cd, Cr, Hg and Zn in the shells decreased significantly with size; the concentrations of Hg and Pb in the soft tissues increased significantly with size; and the concentrations of Cd, Cu and Zn in the soft tissues and those of Cu and Pb in the shells were independent of mussel size. The observed relationships are discussed in relation to physiological and environmental factors, and the implication of the results for the use of the common mussel for monitoring heavy metal pollution are discussed. (See also W88-01460) (Author's abstract)
W88-01481

TROUTS (SALMO GAIRDNERI RICH.) AS BIOINTEGRATORS FOR POLLUTANTS, A NEW METHOD OF RECORDING POLLUTANTS,
Forschungsinstitut fuer Mikrobiologie und Hygiene, Bad Elster (German D.R.).
R. Hallebach.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 273-283, 6 fig, 7 ref.

Descriptors: *Bioindicators, *Bioaccumulation, *Trout, *Heavy metals, *Mathematical models, *Water quality, Drinking water, Water pollution effects, Monitoring, Gills, Kidneys, Liver, Toxicity, Mercury, Kinetics, Fisheries, Water pollution prevention.

A mathematical model is described that detects short-term and intermittent effects of pollutants in running water. The pollutants are taken up by organisms, such as trout, at any time and phase shifting in the level of pollutants in the succession from the resorption organ to the elimination organ allows the determination of the data of effectiveness, of concentration, and the nature of the pollutant. The model can detect the shock caused by heavy metal pollution after months have elapsed since the time of exposure. The process of elimination tells whether the pollutant has been taken up by the fish through the gills or through the intestines. The practical corroboration of the theoretical concepts encompassed in the model were demonstrated in a flow stream apparatus in which trout were exposed to a solution of radioactively-labelled mercury in a concentration of 5 micrograms/l. The present method is useful for pollution control of drinking water supplies and for the surveillance of fisheries. (See also W88-01460) (Geiger-PTT)
W88-01482

TRACE METALS IN EDIBLE CRUSTACEANS FROM LEBANON,
Shiber Consultants, Safat (Kuwait).
For primary bibliographic entry see Field 5B.
W88-01483

TISSUE ACCUMULATION OF HEAVY METALS AND THEIR INFLUENCE ON THE BIOSYNTHESIS IN THE FISH ORGANISM,
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
For primary bibliographic entry see Field 5B.
W88-01484

EXPERIMENTAL STUDY OF BIOACCUMULATION, TOXICITY AND REGULATION OF SOME TRACE METALS IN VARIOUS ESTUARINE AND COASTAL ORGANISMS,
Nantes Univ. (France). Centre de Dosage des Elements Traces.
J. C. Amiard, C. Amiard-Triquet, and C. Metayer.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 313-322, 3 fig, 4 tab, 27 ref.

Descriptors: *Bioaccumulation, *Toxicity, *Trace metals, *Marine animals, *Fish, *Path of pollutants, *Water pollution effects, Crustaceans, Annelids, Mollusks, Cadmium, Copper, Zinc, Lead, Heavy metals, Lethal limits, Estuaries.

The relations between the bioaccumulation and toxicity of essential (Cu, Zn) and non-essential (Cd, Pb) trace metals in estuarine organisms were studied under laboratory conditions in four zoological groups: annelids (Nereis diversicolor), mollusks (Scrobicularia plana), crustaceans (Crangon crangon) and fish (Platichthys flesus). For all four studied species, the Cd and Pb concentrations in organs or entire organisms increased considerably for ascending amounts of these metals. In the case of Cu, the increase of concentrations in water induced an increase of concentrations in Nereis and Scrobicularia. In shrimp, the Cu concentration remained steady for concentrations in water up to 1000 times more than the control concentration and increased only for the highest additional concentration which rose above the LC50/96 hr. For Zn, the regression coefficients relating logarithms of concentrations in organs or organisms to logarithms of concentration in water were very low. In Scrobicularia, the concentration of Zn increased noticeably, only for additional concentrations in water greater than 0.1 mg/l. For the other three species, the concentrations in water must be even higher to induce an appreciable increase of the bioaccumulation of Zn. (See also W88-01460) (Geiger-PTT)
W88-01485

UPTAKE AND RELEASE OF MERCURY AND CADMIUM IN VARIOUS ORGANS OF MUSSELS (ANODONTA CYGNEA L.),
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
For primary bibliographic entry see Field 5B.
W88-01486

INTERACTIONS OF HEAVY METALS AT TISSUE AND CELLULAR LEVEL IN AQUATIC ORGANISMS,
Manchester Univ. (England). Dept. of Botany.
H. B. Akberali, and M. J. Earnshaw.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 343-355, 8 fig, 37 ref.

Descriptors: *Heavy metals, *Toxicity, *Aquatic animals, *Water pollution effects, *Respiration, Calcium, Copper, Models, Eggs, Bioaccumulation, Physiological ecology, Ecological effects, Mytilus, Mussels, Perch, Bioindicators, Zinc, Biochemistry, Tissue analysis.

Three physiological effects brought about by Cu, but not by Zn, which depend both on the nature of the cell as well as its particular physiological status are demonstrated in the siphonal tissue contraction in the mollusk, Scrobicularia plana, the stimulation by Cu of unfertilized egg respiration in the marine bivalve, Mytilus edulis, and the simulation by Cu of unfertilized egg respiration in the Eurasian perch, Perca fluviatilis. In Mytilus, unfertilized egg respiration is only partially released and Cu has an uncoupling effect on mitochondrial respiration possibly by initiating K ion uptake which will consume energy and stimulate egg respiration. In perch eggs, Cu appears to promote oxygen entry by breaking down the permeability barrier located at the chorion which results in the stimulation of respiration. The stimulation of unfertilized egg respiration in Mytilus edulis and Perca fluviatilis prior to fertilization by Cu produces significant perturbations in the metabolite pools and in both cases will presumably lead to a decrease in the total substrate reserves which could affect egg development upon fertilization. By extrapolation, it is also likely that a similar reaction of Cu with the gonadal tissue would lead to disruption of the gametogenic cycle. This type of cellular perturbation brought about by Cu under a given set of circumstances will be determined by the nature of the cell as well as its physiological status at the time. (See also W88-01460) (Geiger-PTT)
W88-01487

EXCRETION OF HEAVY METALS BY FISH,
Bezirksinstitut fuer Veterinarwesen Karl-Marx-Stadt (German D.R.).
For primary bibliographic entry see Field 5B.
W88-01488

BIOCHEMICAL COMPARTMENTATION OF FISH TISSUES, HEAVY METAL TOXICITY ON TISSUE NON-SPECIFIC PHOSPHOMONOESTERASES IN THREE FISHES,
Regional Coll. of Education, Bhopal (India). Dept. of Science.
S. A. Shaffi, and S Jeelani.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 367-386, 12 tab, 20 ref.

Descriptors: *Heavy metals, *Toxicity, *Bioaccumulation, *Fish, *Enzymes, *Path of pollutants, *Water pollution effects, Copper, Lead, Liver, Muscle, Kidneys, Gills, Tissue analysis, Biochemistry.

The viscera were compartmentalized in relation to non-specific phosphomonoesterases in Labeo rohita (Ham), Clarias batrachus (Linn) and Channa punctatus (Bloch), that varies phylogenetically, biochemically, mutritionally and growth rate wise. The effects of various concentrations (5, 10, 15, and 20 ppm) of Cu and Pb were investigated on differential distribution of acid and alkaline phosphatase in the various regions of liver, muscle, kidney and gill tissues of the above mentioned 3 fish species. The highest fall in alkaline and rise in acid phosphatase activity was recorded in the middle and posterior regions of the kidney respectively (L. rohita). In liver, the fall in alkaline and

rise in acid phosphatase level was greater in the anterior part of the left and right lobes respectively. However, in muscle, the fall in alkaline phosphatase in the cephalic region and the rise in the thoracic region for acid phosphatase was optimum. In gill tissue the fall in alkaline and the rise in acid phosphatase was greater in the left lobe than in the right one. In all the three fish species, maximum fall in alkaline and acid phosphatase was recorded in L. rohita then in C. batrachus or C. punctatus. The effects of various concentrations of Cu on tissue non-specific phosphomonoesterases were more pronounced than those of Pb in the above three fish species studied. (See also W88-01460) (Author's abstract)
W88-01489

EFFECTS OF HEAVY METALS ON THE CHEMOSENSITIVITY OF NEURONAL SOMATA OF LYMNAEA STAGNALIS L.,
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
K. S.-Rozsa, and J. Salanki.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 387-399, 11 fig, 13 ref.

Descriptors: *Heavy metals, *Snails, *Toxicity, *Cadmium, *Mercury, *Water pollution effects, Animal physiology, Membrane processes, Invertebrates, Molluska, Animal behavior, Tissue analysis, Biochemistry.

Neurons of the ganglionic ring of the snail, Lymnaea stagnalis were exposed to Cd and Hg to study the specific response to transmitter substances under control conditions and following heavy metal treatment. Acetylcholine (ACh), 5-hydroxytryptamine (5HT), and dopamine (DA) were used as neurotransmitters. Treatment of the ganglia with .000001 M CdCl2 or HgCl2 solution usually did not cause any noticeable effect on the membrane potential or spike generation within 30 min. The biphasic effect of ACh is demonstrated when the short increase in firing frequency of the neuron is followed by a weak inhibitory phase. However, following, CdCl2 treatment, the ACh effect was modulated and as a result an excitatory response of long duration appeared. On another neuron the biphasic effect of ACh was much more expressed than in the previous case, but here, contrarily, the excitatory phase was eliminated under the influence of CdCl2 and the inhibitory one prevailed. In this neuron, bursting pattern was also formed following CdCl2 treatment. On a third neuron neither the excitatory nor the inhibitory phases of ACh response were eliminated by CdCl2 treatment, moreover both were enhanced. The same neuron showed no sensitivity to DA under control conditions but was excited by DA following CdCl2 treatment. 5HT caused inhibitory or excitatory responses on various Lymnaea neurons and both effects were eliminated by CdCl2 treatment. HgCl2 proved to be also an effective modulator of transmitter effects. These results suggest that heavy metals may cause a very profound modulation on the elements of the neural circuitry responsible for the regulation of the animal's behavior. (See also W88-01460) (Geiger-PTT)
W88-01490

HEAVY METAL POLLUTION INFLUENCES SEROTONIN LEVEL AND DOPAMINE-STIMULATED ADENYLATE CYCLASE ACTIVITY IN THE CNS OF MOLLUSCS,
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
L. Hiripi, J. Salanki, G. B. Stefano, and P. A. Assanah.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 401-412, 2 fig, 1 tab, 28 ref.

Descriptors: *Heavy metals, *Mollusks, *Water pollution effects, *Cadmium, *Lead, Enzymes, Animal physiology, Invertebrates, Mytilus, Animal behavior, Mercury, Zinc, Nickel, Iron.

The in vivo effects of Cd and Pb on the serotonin content of the ganglia in Anodonta cygnea L. and the in vitro effects of Pb, Hg, Zn, Fe and Ni ions on the dopamine stimulated adenylate cyclase activity in Mytilus edulis were studied under laboratory conditions. The in vivo treatment of Anodonta with Cd ions influenced moderately the serotonin content of the ganglia. Exposure of the same animals to Pb ions influenced also the ganglionic serotonin content. The addition of 100 micromoles of dopamine to the incubation medium (in vitro) increased the cyclic AMP content of the pedal ganglion homogenates in Mytilus. Pb, Hg, Cu and Zn ions were potent inhibitors of dopamine-stimulated adenylate cyclase activity. Both ferric and nickelous chloride were less potent. At concentrations as low as 0.4 micromole of lead and mercuric chloride, the dopamine-stimulated adenylate cyclase enzyme was inhibited to a significant extent. (See also W88-01460) (Geiger-PTT)
W88-01491

EFFECT OF CU ON SOME BIOCHEMICAL PARAMETERS OF FISHES,
Jozsef Attila Univ., Szeged (Hungary). Dept. of Biochemistry.
J. Nemcsok, L. Orban, E. Vig, B. Asztalos, and L. Boross.
IN: Heavy Metals in Water Organisms. Symposia Biologica Hungarica, Vol. 29. Akademiai Kiado, Budapest, Hungary, 1985. p 413-425, 8 fig, 1 tab, 27 ref.

Descriptors: *Copper, *Heavy metals, *Carp, *Water pollution effects, *Toxicity, *Biochemistry, Fish, Copper, Environmental effects, Ecological effects, Fish toxins, Fish physiology, Enzymes, Industrial wastes, Fungicides.

Studies were carried out on the effect of CuSO4 on several enzymes - aspartate aminotransferase (ASAT), alanine aminotransferase (ALAT), lactate dehydrogenase (LDH), and acetylcholinesterase (AChE) - in common carp (Cyprinus carpio L.), silver carp (Hypophthalmichthys molitrix V.) and European wels (Silurus glanis L.) under laboratory conditions. After 2 hr, the biochemical parameters changed significantly in carps exposed to CuSO4 compared to controls. The ASAT activity increased by about 30% and the ALAT activity was three times as high as in the controls. The most significant changes were observed in silver carp. The ASAT activity and the blood glucose level doubled, while the ALAT and the LDH activities were 2.5 and 4 times higher, respectively. Similar results occurred in the wels; however, CuSO4 was less toxic to wels than the carp. When the exposure time was 2 wk, the ASAT and ALAT activity was generally enhanced in the serum as well. During the long-term treatment with CuSO4, the serum LDH activity and blood sugar level increased as well. At the end of the second week, the serum LDH activity was 15 times higher than in the controls. Blood sugar level reached its maximum after the treatment of the first week, when it was 3 times higher compared to the controls. These results clearly show that the toxicity of CuSO4 affected the three investigated fish species differently. CuSO4 inhibited in vitro the AChE activity of all fish tested; it was most inhibitory in the brain and the least in the heart. The greatest AChE inhibition in vivo was observed in the muscles and the least in the brain. CuSO4 also decreased the proteolytic enzyme acitivty in all investigated fishes. (See also W88-01460) (Geiger-PTT)
W88-01492

FISH, PATHOGENS AND ENVIRONMENT IN EUROPEAN POLYCULTURE.
Symposia Biologica Hungarica, Vol. 23. Akademiai Kiado, Budapest, Hungary. 1984. 265 p. Edited by J. Olah.

Descriptors: *Fish physiology, *Fish parasites, *Fish diseases, *Fish farming, *Water pollution effects, Fish hatcheries, Fish ponds, Fish toxins, Fish behavior, Viruses, Carp, Catfish, Ecological effects, Enzymes, Gills, Ammonia, Toxicity, Morbidity, Infection, Environmental effects.

This volume presents the Proceedings of an International Seminar held in June 1981, in Szarvas, Hungary which was devoted to the combined problems of fish health and adverse environmental effects that have come into the limelight along with rapid development of the European warm water fish culture. The complexity of fish, pathogens, and environment necessitated the organization of interdisciplinary research teams. Special attention was paid to gill-necrosis due to its importance in the carp culture practice of Central and Eastern Europe. Separate chapters of the volume deal with the viral, bacterial and parasitic desease of fish, as well as with the effects of environmental pollutants, and with the results of immunology. A list of conference participants and a subject index are also included. (See W88-01495 thru W88-01498) (Geiger-PTT)
W88-01494

RELATIONSHIP OF WATER QUALITY AND INFECTIOUS DISEASES IN CULTURED CHANNEL CATFISH,
Alabama Agricultural Experiment Station, Auburn.
J. A. Plumb.
IN: Fish, Pathogens and Environment in European Polyculture. Symposia Biologica Hungarica, Vol. 23. Akademiai Kiado, Budapest, Hungary. 1984. p 189-199, 3 fig, 21 ref.

Descriptors: *Catfish, *Fish diseases, *Fish farming, *Water pollution effects, *Water quality management, Carp, Carbon dioxide, Ammonia, Nitrite, Oxygen depletion, Ecological effects, Fish management, Eutrophication, Fish hatcheries.

Channel catfish (Ictalurus punctatus) is the most extensively cultured food fish in the United States. During the past decade an increase in intensity of catfish culture methods has led to a reduction in water quality which increases stress on the fish and makes them more susceptible to disease. Some of the primary water quality characteristics that influence disease susceptibility are high CO2, NH3, and nitrite, and low O2. Although each of these factors is individually stressful to the fish, they reduce disease resistance more significantly in combination. An example of a case involving an O2 depletion as a result of an algal die-off, followed by an Aeromonas hydrophila infection, is described. The relationship of water temperature and alkalinity on disease susceptibility is also discussed. Polyculture utilizing silver carp, tilapia, and grass carp as herbivores in combination with channel catfish to help improve water quality is discussed. (See also W88-01494) (Author's abstract)
W88-01495

TRANSAMINASE ENZYME ACTIVITY OF CYPRINID FISH DEPENDING ON ENVIRONMENTAL FACTORS AND BACTERIAL INFECTION,
Fisheries Research Inst., Szarvas (Hungary).
G. Jeney, J. Nemcsok, and J. Olah.
IN: Fish, Pathogens and Environment in European Polyculture. Symposia Biologica Hungarica, Vol. 23. Akademiai Kiado, Budapest, Hungary. 1984. p 201-207, 4 tab, 5 ref.

Descriptors: *Fish diseases, *Fish physiology, *Carp, *Water pollution effects, *Seasonal variation, Infection, Environmental effects, Ecological effects, Bacteria, Fish toxins, Ammonia, Water temperature, Fish farming.

The transaminase activity (GPT: glutamic acid-pyruvic acid transaminase; GOT: glutamic acid-oxalacetic acid transaminase) in blood was used to detect damage of fish tissues caused by adverse environmental factors and bacterial infection. Serum GOT and GPT activities were determined in three fish species (hypophthalmichthys molitrix, Ctenopharyngodon idella, and Cyprinus carpio) depending on their ages. In all three species the highest enzyme activity was measured in the adult, three-yr-old specimens. There were no significant differences between serum transaminase activity in different species of the same age. Serum transaminase activity of carp was measured as a function of water temperature, seasons, different NH3 concentrations, and bacterial infection. GOT and GPT activities changed parallel with the increase of

water temperature. The highest activity was measured during the summer-period (May-August) while the lowest was recorded in winter. Serum transaminase activity was enhanced together with increased ammonia concentration and with the duration of the treatment illustrating the role of GOT and GPT in ammonia detoxification. This could indicate gill necrosis following ammonia treatment or bacterial infection. The determination of serum transaminase activity in fish proved to be a suitable method for detecting tissue damage caused by adverse environmental factors and bacterial infection. (See also W88-01494) (Geiger-PTT)
W88-01496

EFFECT OF NH3 ON BLOOD GLUCOSE AND CATECHOLAMINE LEVEL, GOT, GPT, LDH ENZYME ACTIVITY AND RESPIRATION OF FISHES,
Jozsef Attila Univ., Szeged (Hungary). Dept. of Biochemistry.
J. Nemcsok, K. Gyore, J. Olah, and L. Boross.
IN: Fish, Pathogens and Environment in European Polyculture. Symposia Biologica Hungarica, Vol. 23. Akademiai Kiado, Budapest, Hungary. 1984. p 209-217, 4 fig, 16 ref.

Descriptors: *Ammonia, *Enzymes, *Water pollution effects, *Carp, *Biochemistry, Fish, Toxicity, Oxygen requirements, Glucose, Respiration, Ecological effects, Environmental effects, Detoxification.

The effects of NH3 on blood sugar- and catecholamine level, LDH (lactic-acid-dehydrogenase), GOT (glutamic acid-oxalacetic acid transaminase), GPT (glutamic acid-pyruvic acid transaminase) activities the respiration of cultured carp, silver carp and sheatfish (weighing 5-15 g) were investigated. A correlation was observed between the NH3 content of the water and the intensity of O2 consumption regarding the three species. Ammonia - as a toxic agent - caused stress in fishes by changing their metabolic processes as it was reflected by the enhanced blood sugar and catecholamine level of the blood sera. Higher NH3 concentration induced anoxia in the tissues. The physiologically toxic NH3 level is neutralized in the organism by normal detoxical processes, more exactly by means of increased GOT and GPT activities. (See also W88-01494) (Author's abstract)
W88-01497

HISTOPATHOLOGICAL DIFFERENTIAL DIAGNOSIS OF GILL CHANGES WITH SPECIAL REGARD TO GILL NECROSIS,
Orszagos Allategeszsegugyi Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 2H.
W88-01498

5D. Waste Treatment Processes

PROCEEDINGS OF THE 39TH INDUSTRIAL WASTE CONFERENCE.
May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. 970 p. Edited by John M. Bell.

Descriptors: *Industrial wastewater, *Conferences, *Wastewater treatment, Chemical wastes, Food-processing wastes, Metal-finishing wastes, Textile mill wastes, Tannery wastes, Oil wastes, Explosives, Land disposal, Pharmaceutical wastes, Agricultural wastes, Pulp and paper industry wastes, Hazardous wastes, Toxicity, Powerplants, Coal, Coke, Industrial wastes, Regulations.

This proceedings volume contains 91 papers relevant to wastewater treatment and pollution control. The papers are classified according to the following general categories: chemical wastes, food wastes, metal wastes, textile wastes, tannery wastes, plating wastes, oil wastes, explosive wastes, land disposal, pharmaceutical wastes, agricultural wastes, paper wastes, hazardous and toxic wastes, coal, coke and powerplant wastes, refinery wastes, laws and regulations, physical/biological systems, and miscellaneous wastes. (See W88-00964 thru W88-01054) (Lantz-PTT)
W88-00963

PHYSICOCHEMICAL TREATMENT OF WASHRACK WASTEWATER,
Camp, Dresser and McKee, Inc., Atlanta, GA.
P. C. Y. Huang, Y. C. Wu, K. C. Ou, and J. K. Bornholm.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 1-6, 8 fig, 1 tab, 5 ref.

Descriptors: *Water reuse, *Wastewater treatment, *Physicochemical treatment, *Industrial wastewater, *Water quality control, Odors, Suspended solids, Cations, Organic polyelectrolytes, Polymers, Alum.

Wastewaters from U.S. Army training and maintenance facilities are typically high in suspended solids and oil, and the majority of oil is in the emulsified state due to the special cleaning technique employed. In addition, the characteristics of wastewater vary significantly pending upon the nature of local water supply, type and quantity of cleaning detergents utilized. The wastewater generated by vehicle and aircraft washings, maintenance activities at overhaul depots, and machine shops, if discharged without treatment, may have an undesirable odor and/or be toxic to bioaquatic life. Therefore, effluents from these facilities are not suitable for direct discharge. Direct recycle and reuse of the dirty water for vehicle washing is not feasible, since the dirty water does not have adequate cleaning power. However, reusing the effluent for the original application, after oil and solids have been removed, is not only practical but also meets the goal of resources conservation. Cationic organic polyelectrolytes are found here to be effective in treating the oily wastewater, and with pH adjustment and alum addition, the treatment efficiency can be significantly improved to well above 90% removal. The polymer dosage can, however, be further reduced and the overall removal efficiency can be better than 95% if the treated wastewater is recycled and mixed with raw wastewater at the ratio of 1.5:1. The recycle of treated wastewater will result in both polymer and NaOH savings. Additional biological treatment will be necessary to ensure that the effluent quality is suitable for direct discharge. (See also W88-00963) (Lantz-PTT)
W88-00964

RELATING THEORY TO PRACTICE IN THE DESIGN OF WATER RECLAMATION FACILITIES FOR ENHANCED OIL RECOVERY STEAMFLOOD FACILITIES,
Brown and Root Development, Inc., Houston, TX.
R. L. Stephenson, P. E. Cooke, and J. C. T. Chen.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 7-14, 5 fig, 1 tab, 6 ref.

Descriptors: *Water reuse, *Wastewater treatment, *Reclaimed water, *Oil recovery, *Steamflood facilities, Suspended solids, Dissolved solids, Emulsions, Sodium chloride, Water treatment, Filtration, Oil, Brine, Water softening.

Oil is produced either by primary methods or by tertiary methods. Oil production by primary methods utilizes the natural pressure that exists in the reservoir. Oil production rates in many reservoirs may be increased by intermittent injection of steam called huff and puff, or by continuous injection of steam called steam-drive or steamflood into the reservoir. This tertiary oil production can recover an additional 30-70% of the oil in place in reservoirs amenable to steamflooding. Because of excessive heat loss, present technology limits steamflooding to reservoirs 3000 feet deep or less. Steam generators produce steam usually in the range of 800-1500 psig and at 80% quality for distribution and injection through multiple wells into the oil reservoir. This produced fluid generally contains high total dissolved solids (TDS) and will contain oil in water emulsions, water in oil (reverse) emulsions, free oil, and may contain hydrogen sulfide, suspended solids (SS), and other undesirable impurities. The water is usually very hard and the high TDS constituents are primarily sodium chloride. Pointed out here are some of the unique aspects of treating and recycling produced water and the areas where design theory works well and where it does not. Potentially productive research subjects include: oil loading rates for various filter media for various types of oils at various temperatures, high temperature backwash rates for oil removal filters, solids loading rates for high temperature filters, resin selection for oil field produced waters, optimum brine concentration for regenerating zeolite softeners softening high sodium content waters, and methods to decrease hardness leakage from produced water softeners. (See also W88-00963) (Lantz-PTT)
W88-00965

COST EFFECTIVE TREATMENTS OF OIL FIELD PRODUCED WASTEWATER FOR 'WET STREAM' GENERATION - A CASE HISTORY,
Brown and Root Development, Inc., Houston, TX.
J. C. T. Chen, and R. L. Stephenson.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 15-21, 6 fig, 4 tab, 6 ref.

Descriptors: *Water treatment, *Oil fields, *Wastewater treatment, *Case studies, Steamflood operations, Cost-benefit analysis, Oil recovery, Temperature, Oxygen, Costs.

The selection of water sources and treatment processes for a 12.5-migd plant based on the water quantity and quality requirements for steamflood operations, are described. Viable treatment alternatives are presented for various water sources including fresh surface water and oil field produced wastewater (produced water). The reuse or recycling of the oil field produced water is determined, and factors which favor the reuse of produced water include: higher temperature of produced water, lower oxygen content in the produced water, and less disposal costs. The heat value of the offsite and onsite areas' produced water is in excess of $661.8 million for the life of the project when compared with the use of river water. This more than justifies the rejection of river water as a source of water. It is recommended that the use of offsite area produced water be maximized. This water is relatively soft and has a substantial heat value. An insulated pipeline is required to transport this water which has an estimated construction cost of $10,860,000. It is further recommended that the treatment train consist of oil skimming and waste pit, flotation unit feed pumps, mechanical gas flotation units, water treatment process pumps, sand-garnet filters, sodium cycle series softeners, surge tank and feedwater pumps. It is further recommended that zeolite softeners be designed for both on-site and off-site areas' produced water. (See also W88-00963) (Lantz-PTT)
W88-00966

NEW APPLICATION FOR ULTRAFILTRATION WASTEWATER TREATMENT IN THE INDUSTRIAL ENVIRONMENT,
Adolph Coors Co., Golden, CO.
P. McTeer, W. Word, and K. Lewandowski.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 23-26, 2 fig.

Descriptors: *Wastewater treatment, *Ultrafiltration, *Industrial wastewater, *Filtration, Air flotation, Hydrogen ion concentration, Temperature.

Coors Container Company, a division of Adolph Coors Company, is the largest manufacturer of aluminum cans at one location in the world. The wastewater treatment system that has been used for the past 11 years is a chemical dissolved air flotation (D.A.F.) system. The D.A.F. employs both a cationic and an anionic polymer for separating contaminants from the wastewater. A more efficient waste treatment system was sought. The major drawbacks of the D.A.F. system are: (1) treatment of an excessive amount of water; (2) oil

and grease levels of the effluent water are directly proportional to the influent process water, and tests have proven that although the D.A.F. system is 90% efficient, a high value of oil and grease in the influent will push the effluent out of the specification range of less than 50 mg/L; (3) cost of the polymer chemicals; (4) cost of operation and maintenance of the decantor centrifuge; and (5) cost of sludge hauling. Testing of new methods narrowed down to ultrafiltration treatments. After researching further into large channel ultrafiltration, it was decided that tubular membranes could offer the flexibility sought while meeting the effluent plant specifications for wastewater. A pilot system was rented and preliminary testing was scheduled. Three different types of membranes were suggested by the vendor, and a test was designed to screen for: (1) determination of an economical flux rate curve; (2) quality of permeate; and (3) economics of membranes. Final tests were conducted to evaluate: (1) pH; (2) temperature of process water; (3) concentration of process tank; and (4) bleed rate of concentrate. All tests were encouraging and it was felt that a new wastewater treatment system was found. (See also W88-00963) (Lantz-PTT)
W88-00967

PROCESS CONTROLLER FOR TREATING WASTE OILS IN AUTOMOTIVE WASTE TREATMENT PLANTS,
Nalco Chemical Co., Oak Brook, IL.
S. R. Srivatsa, and E. C. Zuerner.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 27-35, 12 fig, 3 tab, 2 ref.

Descriptors: *Wastewater treatment, *Oil recovery, *Industrial wastewater, *Process control, Water quality control, Monitoring, Oil wastes, Viscosity monitoring, Optimization, Chemical analysis, Economic aspects.

Batch cooking processes are generally implemented in the recovery of oil from waste oil scum. These processes consist of heating the waste oil scum followed by addition of emulsion breaking chemicals to produce an oil-water resolution. Waste oil scums are water-in-oil emulsions generated in processes utilizing water, oil, cleaners, etc., in the machining and working of metals. Automotive industries comprise the major source for waste oil scum. Other sources are refineries, steel-rolling mills, canning industries, chemical processing and hydrocarbon processing industries. A revolutionary on-line technique optimizes chemical feed and energy requirements in automotive waste oil cookers. Case histories illustrate the success of this technique in its capacity to maximize yields and improve process economics. This technique, viscosity monitoring, provides a twofold advantage over conventional methods: first, as a valuable tool in bench scale-up for batch chemical optimization and periodic spot checks, and second, in the form of an in-line process controller for chemical optimization. In either case, the concept has proven to considerably enhance the overall economics of a batch cooking process. Future work consists of developing the controller as a support package for treatment processes that handle waste oil scum. (See also W88-00963) (Lantz-PTT)
W88-00968

CASE STUDY: IN SITU SOLIDIFICATION/ FIXATION OF OIL FIELD PRODUCTION FLUIDS - A NOVEL TECHNIQUE,
ENRECO, Inc., Amarillo, TX.a
D. T. Musser, and R. L. Smith.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 37-43, 4 fig, 3 tab.

Descriptors: *Solidification, *Wastewater treatment, *Oil fields, *Oklahoma, *Fixation, *Waste disposal, *Industrial wastewater, Oil wastes, Solids, Settling basins, Brines, Sludge, Kiln dust, Heavy metals, Leaching.

In 1969, a major oil company operating in Oklahoma constructed a skim pit to be used for water retention, solids settling, and oil skimming. The pit was originally lined with a synthetic liner. Over one million gallons of brine water from 55 wells flowed through this pit daily. Since this was an open system, the pit eventually became contaminated with leaves, windblown dust, and dirt particles. Drilling fluids and muds were also dumped into the pit. In 1981, a decision was made to change from an open pit system to a closed tank system because of production problems caused by contaminants. All of the oil that could be reclaimed was skimmed from the surface of the pit and sent to a refinery. All that remained was brine water sandwiched between an oily sludge on the bottom of the pit and an encrusted oil layer on the surface. The objective of the production company was to close the pit in an environmentally acceptable and cost efficient manner. In situ solidification/ fixation of oil field skim pit sludge may often be a practical and environmentally acceptable disposal alternative. The incorporation of kiln dust into the sludge with a system that provides suitable mixing can produce a compactable material with adequate load bearing characteristics. Laboratory analysis of the sludge after solidification showed favorable physical and chemical characteristics. In general, leachability of the heavy metals present in the sludge was reduced by solidification. Significant reductions were recorded in the leachability of arsenic and barium although the cadmium content in the leachate did increase on stabilization. (See also W88-00963) (Lantz-PTT)
W88-00969

CHEMICAL AND BIOLOGICAL TREATABILITY OF HIGH WATER CONTENT FLUIDS USED BY FORD MOTOR COMPANY,
McNamee, Porter and Seeley, Ann Arbor, MI.
S. J. Kang, L. B. Pugh, and P. Lawrence.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 45-55, 5 fig, 8 tab, 4 ref.

Descriptors: *Industrial wastewater, *Pretreatment of wastewater, *Wastewater treatment, *Chemical treatment, *Biological treatment, *Ford Motor Company, Organic compounds, Chemical oxygen demand, Alcohols, Glycols, Fatty acids, Activated sludge.

A chemical pretreatment study was conducted to determine the impact of High Water Content Fluids (HWCF's) on the chemical treatment of wastewater at Ford Motor Company plants where these fluids are presently used or may be used in the future. Twelve HWCF's were studied by spiking each HWCF into background wastewater and using jar tests, and each HWCF was classified according to its major components. Based on the jar testing and subsequent chemical analyses, the following is concluded: (1) Chemical pretreatment using the Modified Windsor Process was the most effective treatment scheme for both the background wastewater and the spiked wastewater; (2) The highest chemical dosages were required for treatment of the fatty acid group; (3) The HWCF's chosen for the biological treatability study based on their higher residual organic strength (COD) after chemical pretreatment were the glycol, two alcohol amines and one fatty acid; (4) The microemulsions exhibited the lowest residual COD concentrations after chemical pretreatment; (5) Alcohol amines exhibited a higher freon extraction concentration after pretreatment; and (6) The zinc concentrations in the treated water phase were not linear with HWCF spikes. Four HWCF's from the group of 12, were selected for the biological treatment study based on their residual COD in response to chemical pretreatment. The selected HWCF's were one fatty acid, one glycol, and two alcohol-amine condensates. The findings of these studies are summarized. (See also W88-00963) (Lantz-PTT)
W88-00970

USE OF METHANE GAS FROM ANAEROBIC TREATMENT OF STILLAGE FOR FUEL ALCOHOL PRODUCTION,
Oklahoma State Univ., Stillwater. School of Civil Engineering.
E. L. Stover, G. Gomathinayagam, and R. Gonzalez.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 57-63, 3 fig, 5 tab, 5 ref.

Descriptors: *Methane, *Anaerobic digestion, *Wastewater treatment, *Fuel, *Stillage, *Ethanol, *Energy, Industrial wastewater, Fermentation, Costs.

In recent years fermentation of ethanol from agricultural feed stocks, such as corn and milo, has been demonstrated to be a promising energy alternative for the United States. Gasohol, a blend of 10% anhydrous ethanol and 90% unleaded gasoline, has been shown to be compatible with 100% unleaded gasoline and has received widespread public acceptance. However, there are two very serious problems of this industry which center around the energy consumption requirements to produce the alcohol and the production of high-temperature, high-strength, acidic wastewaters called thin stillage. Heat energy is required at every stage of the production process including grain drying, cooking, saccharification, fermentation, and distillation. Unless careful design and operation constraints are imposed, the energy consumption per gallon of alcohol produced can be greater than the energy available from one gallon of alcohol. Thus, the total energy balance around the production plant becomes a critical factor, and innovative improvements to reduce the total process energy demands are needed. Ethanol production by fermentation also requires considerable quantities of water with substantial amounts ending up in the thin stillage as wastewater. Although a portion of this water can be recycled, complete reuse is generally not possible due to the build-up of salts and toxic by-products of the fermentation reactions. These high strength wastewaters can be treated biologically to high treatment efficiencies in both aerobic and anaerobic systems. The anaerobic systems offer the advantage of methane gas production which can be used as a fuel source back in the alcohol production process. (See also W88-00963) (Lantz-PTT)
W88-00971

PILOT-SCALE ANAEROBIC TREATMENT OF CORN WET MILLING WASTEWATER,
ADI Ltd., Fredericton (New Brunswick).
R. C. Landine, G. J. Brown, and A. A. Cocci.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 65-71, 7 fig, 4 tab, 1 ref.

Descriptors: *Pilot plants, *Wastewater treatment, *Anaerobic digestion, *Corn mill wastewater, Industrial wastewater, Bulk volume fermentors, Fermentation, Energy, Simulation analysis, Costs, Chemical oxygen demand, Suspended solids, Biological oxygen demand.

In mid-1983, ADI International Inc. was commissioned by a corn wet milling plant in North Central, USA to carry out a six-month anaerobic treatability pilot-scale study. The anaerobic technology chosen for the pilot study was the ADI-BVF (bulk volume fermenter), which is a low-rate process. This choice was based upon wastewater characteristics, site considerations, and the many possible advantages that this technology held, including: ability to absorb shock loads, economical construction and operation, reliable wastewater treatment, digestion of waste solids, energy recovery through biogas recovery, and simplicity of operation. The primary objective of the pilot study was to verify treatability of this waste and simulate full-scale operation so that full-scale design parameters and costs could be established. A secondary objective of the study was to provide existing operators with operating experience for this type of treatment. Results of the pilot operation illustrate that the low-rate BVF process is well suited for anaerobic treatment of this corn wet milling wastewater even when it contains 1,000 mg/L of sulfates with peaks of 1,500 mg/L. COD, BOD and SS removals were excellent at both 7 and 5 day hydraulic retention

times. During the pilot study, approximately 0.31 cu m of methane was collected for every kilogram of COD removed (or 5.0 cu ft/lb COD removed). The particulate matter digested very well with 92% digestion of volatile suspended solids occurring over the 197-day study period. (See also W88-00963) (Lantz-PTT)
W88-00972

EFFECTS OF AMMONIA NITROGEN ON THE ANAEROBIC DIGESTION OF POULTRY MANURE,
Wisconsin Univ.-Madison. Dept. of Civil and Environmental Engineering.
L. E. Ripley, N. M. Kmet, W. C. Boyle, and J. C. Converse.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 73-80, 2 fig, 3 tab, 13 ref.

Descriptors: *Ammonia, *Nitrogen compounds, *Anaerobic digestion, *Poultry, *Manure, *Waste treatment, Methane bacteria, Hydraulic retention time, Alkalinity, Biological treatment.

The anaerobic digestion process is often upset by inhibitory or toxic substances such as ammonia. Successful digestion of wastes rich in organic or ammonia nitrogen requires identification of threshold ammonia concentrations at which methanogenic bacteria begin to suffer. Previous studies of poultry manure, successfully operated bench-scale digesters at ammonia concentrations as high as 3150 mg N/L with a 130 mg/L free ammonia concentration. Studies have described a full-scale poultry manure digester operating with ammonia concentrations of 6200-8000 mg N/L and resulting free ammonia concentrations of 260-340 mg/L. It was unclear to what extent the digester's methane production rate was limited by the high ammonia concentrations. In this study, poultry manure digesters receiving 4.0% volatile solids (VS) feed, with 20-day and 30-day hydraulic retention times (HRTs), experienced no methanogen inhibition at elevated ammonia concentrations of 4000 mg N/L (free ammonia less than 200 mg N/L). At an ammonia concentration of 6280 mg N/L (free ammonia = 345 mg N/L), the 30-day HRT digester demonstrated a statistically significant drop in the methane/feed ratio. The 20-day HRT digester, at an ammonia concentration of 6500 mg N/L (free ammonia = 328 mg N/L) demonstrated a decrease in volatile solids destruction and a sharp increase in volatile acids, but its methane/feed ratio did not decrease significantly. While this study does not predict inhibitory ammonia concentrations for digestion of wastes other than poultry manure, it should be noted that there is not an absolute methanogen threshold in the 150-300 mg N/L range as is often suggested. Careful start-up and an acclimation period of several months is necessary for successful operation of a poultry manure digester. Intermediate alkalinity, from pH 5.75 to pH 4.3, proved to be a useful monitoring parameter. (See also W88-00963) (Lantz-PTT)
W88-00973

NICKEL REMOVAL FROM SYNTHETIC AND ACTUAL NICKEL PLATING WASTEWATER USING SULFIDE AND CARBONATE FOR PRECIPITATION AND COPRECIPITATION,
Auburn Univ., AL. Dept. of Civil Engineering.
S. McAnally, L. Benefield, and R. B. Reed.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 81-98, 11 fig, 9 tab, 10 ref.

Descriptors: *Wastewater treatment, *Nickel, *Sulfides, *Carbonates, *Chemical precipitation, *Metal-finishing wastes, *Chemical treatment, *Model studies, Industrial wastewater, Hydrogen ion concentration, Multiple regression analysis, Mathematical models.

This study is an extension of an earlier study which was conducted to determine an efficient, economical approach for treating an industrial wastewater with a high nickel concentration. The previous study was an investigation of the effect of pH, total carbonate, and total sulfide content on the nickel precipitation-coprecipitation reactions of synthetic wastewater. Results here indicate that the most efficient nickel removal by hydroxide precipitation for the actual wastewater occurred at pH 10. The multiple regression analysis for the synthetic and actual wastewater systems produced equations that predicted the relative response of the true data points quite accurately. The mathematical models for the synthetic wastewater (produced by use of data from pH's 9 and 10) for the residual total and soluble nickel concentrations differed significantly from the corresponding models of the actual wastewater. This difference was attributed to: (1) High iron concentration in the actual wastewater which was not present in the synthetic wastewater; (2) Different ranges of the total carbonate:nickel weight ratios for the actual wastewater (0.0 to 2.0) and the synthetic wastewater (0.0 to 20.0); and (3) Variation of the initial nickel concentrations in the actual wastewater due to dilution during sodium sulfide addition. The economic analysis indicated that maximum removal would occur at pH 11 with a carbonate concentration of 100 mg/L as CaCO3 and no sulfide addition. This conclusion is based on extrapolated results from the synthetic wastewater system. Treatment at pH 10 with a carbonate concentration of 110 mg/L as CaCO3 and no sulfide addition was also found to be an effective treatment. (See also W88-00963) (Lantz-PTT)
W88-00974

EFFECTS OF PH AND PROPORTIONING OF FERROUS AND SULFIDE REDUCTION CHEMICALS ON ELECTROPLATING WASTE TREATMENT SLUDGE PRODUCTION,
Air Force Engineering and Services Center, Tyndall AFB, FL.
J. R. Aldrich.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 99-112, 10 fig, 16 ref.

Descriptors: *Hydrogen ion concentration, *Chemical precipitation, *Sulfides, *Electroplating, *Wastewater treatment, *Sludge, *Chemical treatment, Heavy metals, Cadmium, Alkalinity, Chromium.

In general, electroplating wastewaters bearing heavy metals such as copper, cadmium, nickel, and chromium are relatively easy to treat in chemical precipitation systems. While most chemical treatments work well from the standpoint of effluent quality, the quantity of sludge produced by the different processes can vary dramatically. To address this problem, an Air Force research program was initiated to investigate the sludge volumes produced by the more common reduction chemicals. Even though Air Force treatment plants must treat mixed-metal wastes, chromium was singled out for this study because it alone requires both reduction and hydroxide precipitation. This study found that the 300% increase in the reduction capability of sulfide with the 10-%. Reaction has an even greater impact on the sludge volume. A 75% reduction in sludge (from 8.1 mg/mg to 2.0 mg/mg) was measured in the 10-% Reaction compared to 'standard' acidic treatment using only ferrous sulfate. In addition to the related reduced sludge disposal costs, further savings can be realized in this new method by the elimination of chemicals to reduce the influent pH to acidic levels for reduction, then raise the pH to alkaline levels for precipitation. At all pH levels investigated, good results in both reaction rate and floc formation were observed. It is very possible that pH adjustment could be limited to only standby alkaline addition. The only critical factor in the 10-% Reaction is the reduction of chromium to the trivalent state. Hence, control of a treatment system could be easily accomplished colorimetrically with a feedback system using the standard diphenolcarbazide (DPC) reaction. Preliminary work has shown that the color formation can be driven quickly by using sulfuric acid and an overdose of DPC. Because it is an alkaline reaction, once the chromium is reduced, all the heavy metals common to the plating waste streams will precipitate. Cadmium, which has a relatively high solubility at pH 8.0 would be precipitated as a sulfide. Simplicity and efficiency make the 10-% Reaction a very viable alternative to standard treatment technologies. (See also W88-00963) (Lantz-PTT)
W88-00975

FIXATION OF ELECTROPLATING WASTE SLUDGES,
Missouri Univ., Columbia. Dept. of Civil Engineering.
H. Johnnesmeyer, and M. Ghosh.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 113-119, 2 fig, 10 ref.

Descriptors: *Fixation, *Waste treatment, *Sludge, *Waste disposal, *Electroplating, *Metal-finishing wastes, Silicates, Fly ash, Lime, Solidification, Chromium, Cadmium, Heavy metals.

Land disposal is considered by many to be the most objectionable method of hazardous waste disposal. Consequently, many industries have turned to treatment techniques that reduce the toxicity of the solid wastes prior to burial. These techniques, referred to as solidification/stabilization (fixation) processes, are used to treat industrial sludges that contain hazardous constituents to prevent dissolution or loss of toxic material into the environment. The objective of this study was to investigate the effectiveness of two fixation techniques, namely silicate-cement fixation (Method A) and fly ash-lime fixation (Method B), on an electroplating waste sludge. These two fixation techniques, when applied to an electroplating wastewater sludge, were capable of reducing the leaching of chromium and cadmium from the treated product. The pH of the solidified product is not an important factor in determining how effective the method is at immobilizing chromium and cadmium. The electroplating (EP) solution pH for method A was lower than method B, but method A released lower concentrations of Cr and Cd than method B. The EP test is more conservative than the column leach test since it produced samples with higher Cr and Cd concentration. Land disposal of material treated by these methods should be segregated from acid conditions like those found in typical sanitary landfills. Method A was much more effective than method b in immobilizing Cr and Cd during the EP and column leach tests. Both methods showed a loss of Cr and Cd over the period of the study. However, method A released considerably lower amounts than method B. The silicate content in the mixture influences the fixation qualities of both methods. The larger the silicate content, the more effective the method was at immobilizing Cr and Cd. (See also W88-00963) (Lantz-PTT)
W88-00976

TREATABILITY OF DIVERSE WASTE STREAMS IN THE PACT ACTIVATED CARBON-BIOLOGICAL PROCESS,
Du Pont de Nemours (E.I.) and Co., Deepwater, NJ. Chambers Works.
R. W. Soderberg, and R. E. Bockrath.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 121-127, 4 fig, 5 tab.

Descriptors: *Wastewater treatment, *Activated carbon, *Biological treatment, *Chemical wastes, *Organic compounds, Wastewater facilities, Biomass, Biological oxygen demand, Color.

DuPont operates a large diversified organic chemicals manufacturing plant (Chambers Works) at Deepwater Point in southern New Jersey. Major product groups at this facility are nitrated, chlorinated and/or aminated derivatives of benzenoid chemicals, aliphatic surfactants, Freon fluorocarbons, elastomers, and petroleum additives. A large wastewater treatment plant handles aqueous wastes not only from on-plant processes, but also from other DuPont plants and from outside customers. Test procedures used in screening new aqueous waste candidates consist of screening tests for all candidates and more intensive tests for those

whose organic content would be a significant fraction of the total organic load to the treatment plant. The screening tests include tests for specific compounds which are toxic to either humans or biomass and an endogenous biochemical oxygen uptake test which determines whether the candidate inhibits biomass respiratory activity. The more intensive tests utilize Eckenfelder-type bench-top aerators. The waste candidate, either separately or along with regular plant wastewater, is fed to the aerator and removal of parameters including BOD, dissolved organic carbon, and color is monitored. Depending on information required, the feed can be continuous over as much as several months or can be in the form of brief 'spikes' in order to determine transient changes in parameter concentration in the effluent. The Chambers Works wastewater treatment plant is versatile because it can handle both acid and alkaline wastes and can treat organics of varying biodegradability with the combined biological-activated carbon secondary treatment. These attributes, together with its relatively large capacity, allow it to handle most aqueous chemical waste candidates. (See also W88-00963) (Lantz-PTT)
W88-00977

CHEMICAL RESIDUE DISPOSAL WITH HEAT RECOVERY,
Union Carbide Corp., South Charleston, WV. Engineering, Mfg. and Technology Services Div.
For primary bibliographic entry see Field 5E.
W88-00978

WASTEWATER TREATMENT FACILITIES FOR EXXON'S NEW CORPORATE RESEARCH FACILITIES,
Exxon Research and Engineering Co., Florham Park, NJ.
R. W. Powell, and F. L. Robertaccio.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 139-145, 9 fig, 2 tab.

Descriptors: *Wastewater treatment, *EXXON, *Industrial wastewater, *Waste disposal, Sludge, Activated sludge, Chlorination, Waste storage, Sanitary wastewater, Discharge capacity.

In late 1983, Exxon Research and Engineering relocated its Headquarters and Corporate Research facilities to Clinton Township, New Jersey, in rural Hunterdon County about 50 miles west of New York City. The 800 laboratory and pilot plant researchers at Exxon's Clinton site carry out ever-changing activities as diverse as catalysis, biosciences, metallurgy and laser science. This paper provides an overview of the water conservation and wastewater treatment practices at the site which serve to bridge the gap between the highly variable wastewaters and the sensitive environmental demands. In particular, the paper describes innovative facilities to treat two waste streams (sanitary and laboratory) to meet wastewater discharge requirements for a small trout maintenance stream and/or to be suitable for use as spray irrigation water. Treatment and disposal for sanitary wastewater include flow equalization, extended aeration activated sludge, chlorination, storage, and spray irrigation. Approximately 90 days storage is provided in lined lagoons for the treated sanitary wastewater to allow for days when spray irrigation cannot be practiced because of frozen or wet ground. Approximately 30 days storage is provided in lined lagoons for the treated laboratory wastewater to allow for days when the receiving stream flow is too low and spray irrigation cannot be practiced. The sludge handling and disposal system is also illustrated. Aerobically digested waste sanitary sludge, thickened chemical sludge, the thickened PACT sludge are all dewatered on-site in a single gravity belt filter press. Hazardous and non-hazardous sludges are stored separately for contracted offsite disposal. (See also W88-00963) (Lantz-PTT)
W88-00979

STAUFFER'S UTILIZATION OF WASTE PRODUCTS AS FUEL,
Stauffer Chemical Co., Westport, CT. Sulfuric Products Div.
For primary bibliographic entry see Field 5E.
W88-00980

JOINT WASTEWATER MANAGEMENT FOR A CLUSTER OF TANNERIES AT KANPUR,
Indian Inst. of Tech., Bombay. Centre for Environmental Science and Engineering.
P. V. Cheda, U. V. Mandlekar, B. K. Handa, and P. Khanna.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 151-162, 11 fig, 8 tab, 6 ref.

Descriptors: *Wastewater treatment, *Kanpur, *India, *Tannery wastes, *Wastewater management, *Ganges River, Chromium, Biological oxygen demand, Hydrogen ion concentration, Suspended solids, Costs, Economic aspects, Management planning.

The tannery complex at Kanpur consists of 42 vegetable tanneries and 9 each of chrome and mixed tanneries producing 125 tons of leather and 5.2 million L of wastewater/day, with high suspended solids, high BOD, variable pH and high concentrations of tanning and chromium. The untreated and partially treated wastewater presently flows into the Ganges creating obnoxious conditions in the holy river. The management scheme includes appropriate cost-effective pretreatment arrangements to preclude conditions leading to the formation of lime mortar in the conveyance system, optimal design of wastewater treatment system incorporating a carrousel oxidation ditch. Also included in the management scheme is the design of a chromium recovery system. This paper also presents detailed analysis along with the guidelines for the apportionment of annual financial burden to contributing tanneries based on 'Polluter-pays' principle. (See also W88-00963) (Lantz-PTT)
W88-00981

OZONOLYSIS OF WASTEWATERS USING A SPINNING DISC REACTOR,
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
G. K. Anderson, C. B. Saw, and C. R. Howarth.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 163-172, 11 fig, 18 ref.

Descriptors: *Ozonolysis, *Wastewater treatment, *Spinning disc reactors, *Ozonation, Tertiary wastewater treatment, Ozone, Biodegradation, Biological oxygen demand, Chemical oxygen demand, Organic carbon, Color, Turbidity, Suspended solids.

If discharge standards are outside the capability of conventional secondary treatment processes, then the secondary effluents will have to be subjected to 'tertiary treatment.' Many techniques have been developed for the treatment of secondary effluent, e.g., microstraining, rapid gravity sand filtration, lagooning, carbon adsorption, ion exchange and reverse osmosis. The inclusion of ozonation in this list has only been considered in recent years but is becoming more widespread, particularly in Europe, USA, Russia, and Japan. The use of ozone as a tertiary treatment process for wastewater results in increased biodegradability and a reduction of BOD, COD, TOC, color, turbidity, and suspended solids. Disinfection of the wastewater occurs simultaneously. It was found that ozone in conjunction with this equipment was particularly useful for tertiary treatment. A conceptual model for the oxidation of effluent using the spinning disc reactor has been postulated. In the spinning disc contactor, every element of liquid can be brought into contact with the gaseous phase for particle oxidation or disinfection and simultaneous liquid phase reactions occur. Hence, the reactor is conducive for promoting a 'direct reaction' of molecular ozone, or a 'free radical' type reaction. At present, hydrodynamic studies with non-reactive gases carried out on grooved discs and perforated discs have shown great improvements in the mass transfer coefficient. Further work on effluent treatment is needed to investigate the use of 'cartridges' of such discs rather than a single disc. (See also W88-00963) (Lantz-PTT)
W88-00982

TREATMENT OF COAL LIQUEFACTION WASTE WITH PAC-ENHANCED ACTIVATED SLUDGE PROCESS,
Louisville Univ., KY. Dept. of Chemical and Environmental Engineering.
K.-C. Tsai, and C. M. Folsom.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 173-185, 12 fig, 3 tab, 10 ref.

Descriptors: *Wastewater treatment, *Liquefaction, *Activated sludge, *Powdered activated carbon, Organic carbon, Color, Nitrification, Coal, Ammonia, Biological oxygen demand, Chemical oxygen demand, Nitrogen.

The addition of powdered activated carbon (PAC) in activated sludge process, called PAC-enhanced activated sludge or PACT process, has been reported by many researchers to have several advantages over ordinary activated sludge without PAC addition. Notably among them are improved organics removal, better ability to handle toxic and shock loadings, higher color removal, more odor reduction, reduced foaming and provision of extra oxygen reservoir under anoxic conditions. A high degree of nitrification was evident for both PAC-enhanced and non-PAC reactors. The addition of PAC to the activated sludge reactor treating coal liquefaction (H-Coal) wastewater had little or no effect on the removal of ammonia nitrogen due primarily to a high proportion of non-adsorbable nitrogenous materials in the influent feed. Excellent sulfide removal was achieved as more than 99.99% of influent sulfide were removed through both PAC-enhanced and non-PAC units. Results of batch air stripping tests confirmed that the primary mechanism for sulfide removal in the reactor was physical stripping rather than biological oxidation. The PAC-enhanced unit generally had better BOD removal than the non-PAC unit. But, similar to COD removal, the difference was not great enough to warrant the addition of PAC. Phenol removal in both reactors was high at 99.9% or higher. There is essentially no difference in phenol removal between PAC and non-PAC reactors. The PAC-enhanced unit produced a sludge with higher zone settling velocity and lower sludge volume index as compared with non-PAC unit. Biological activity in the PAC-enhanced reactor was also higher as evidenced by the higher oxygen uptake rates. This was particularly true during the high COD loading run. (See also W88-00963) (Lantz-PTT)
W88-00983

CHEMISTRY OF LEACHATES FROM RAW AND STABILIZED COAL FIRED WASTES,
Northwestern Univ., Evanston, IL. Dept. of Civil Engineering.
L. D. Tickanen, and J. A. FitzPatrick.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 187-199, 10 fig, 5 tab, 22 ref.

Descriptors: *Wastewater treatment, *Leachates, *Coal, *Model studies, Industrial wastes, Heavy metals, Computer programs, Chemical treatment, Desulfurization, Hydrogen ion concentration, Sulfites, Barium, Silver, Cadmium, Nickel, Copper, Chromium, Arsenic.

The computer code MINEQL was used as a precipitation/complexation model to predict the solution chemistry of leachates from various extractions of flue gas desulfurization (FGD) sludge and fly ash with fair to good accuracy. Model discrepancies seem in most cases to involve thermodynamic data deficiencies for ash mineral chemistry or neglect of adsorption phenomena. Uncertain behavior of reduced species may be additional

causes for deviations. The extraction pH was varied from 3 for acetic acid extractions to 12 deionized waster extractions. Acid extractions contained up to 1000 times the metals concentrations noted for water extracts. However, none of the EPA extraction metals demonstrated characteristics of electroplating (EP) toxicity (concentration 100 times drinking water standard) in any of the leachates studied. Model predictions indicate that the same should hold for intermediate values of pH (4-11) as well. Forced oxidation of sulfite in sludges to sulfate should decrease solubilities of barium and silver. Barium, although considered to be one of the least hazardous of heavy metals, would be precipitated as BaSO4. Similarly, oxidation of sulfite to sulfate should remove SO3(2-) as a complexing agent for silver allowing precipitation of AgCl to occur. Cadmium, Ni, Cu, Cr, and As are thought to be removed by adsorption and, in some cases, a combination of adsorption and chemical reduction. Work is needed to more clearly define the redox environment in systems where the redox intensity is defined by the sulfate/sulfite couple. Sulfate and sulfite determinations along with pH measurements and determinations of trace metal valence states could provide useful information. Such an approach could be adapted to study other systems where a predominate redox couple may determine system redox intensity. The effectiveness of metals removal by ash and ash/scrubber sludge mixtures further points to their potential utility in the fixation of liquid aqueous wastes. (See also W88-00963) (Lantz-PTT)
W88-00984

TREATMENT OF ACID MINE WATER DISCHARGING INTO THE TAR CREEK WATERSHED,
Oklahoma State Univ., Stillwater. School of Civil Engineering.
M. H. Bates, J. N. Veenstra, J. Barber, R. Bernard, and J. Karleskint.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 201-213, 22 fig, 7 tab, 5 ref.

Descriptors: *Water pollution treatment, *Acid mine drainage, *Heavy metals, *Acidic water, *Mine wastes, *Tar Creek, *Wastewater treatment, Oklahoma, Watersheds, Chemical treatment, Activated carbon, Biological treatment, Iron, Zinc, Cadmium, Lead, Hydrogen ion concentration, Activated sludge.

In October 1981 the Tar Creek area of Oklahoma, was identified as one of the major hazardous waste sites in the United States, and as such, it was then eligible to receive Superfund money. Many alternatives for control of management of the drainage and its subsequent adverse environmental effects have been investigated. The purpose of this study was to specifically evaluate chemical and biological treatment technologies for treating the drainage. In addition, initial studies on the use of activated carbon and ion exchange for metal removal were conducted. Chemical precipitation with a pH of 10 was found to provide maximum removal of Fe, Zn, Cd, and Pb. The addition of polymers reduced the pH necessary for maximum metal removal to 9. Iron can be removed to produce effluents of suitable quality without the necessity of a pre-aeration step with chemical precipitation. Activated sludge or a rotating biological contactor can be used to treat drainage; however, the waste must be diluted 20:1 to preclude inhibition of the microbial population. With respect to activated sludge, the higher sludge ages produce the best treatment. Iron removal with both activated sludge and a rotating biological contactor is a combination of chemical as well as biological reactions since the processes are aerobic. Preliminary data indicate that activated carbon sorption and ion exchange can be used to remove the heavy metals; however, pre-aeration would be required for iron removal. (See also W88-00963) (Lantz-PTT)
W88-00985

DEVELOPMENT OF A NEW RADIUM REMOVAL PROCESS FOR URANIUM MINING EFFLUENTS,
Alberta Univ., Edmonton. Dept. of Civil Engineering.
P. M. Huck, W. B. Anderson, and R. C. Andrews.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 215-222, 3 fig, 6 tab, 7 ref.

Descriptors: *Chemical precipitation, *Wastewater treatment, *Radium, *Radioactive wastes, *Uranium, *Mine wastes, *Effluents, Fluidized bed process, Barium chloride.

A new radium removal process for uranium mining effluents has been successfully developed and tested at bench scale. In this fluidized bed process barium chloride is used to precipitate radium-226 directly onto the surface of a free draining granular material. The process provides total radium-226 removals of 90 to 95% in a contact time of approximately 20 seconds. This time is orders of magnitude less than that required by existing pond and mechanical systems while barium chloride does is similar. The short contact time and absence of a solids-separation step make the process simple and compact. It is anticipated that it would be considerably cheaper than conventional processes. Percentage removals appear to be independent of average influence radium-226 activity levels. Strict effluent requirements can be met by operation of two reactors in series, if necessary. It is expected, however, that additional process optimization can improve effluent levels even further. The process appears to be relatively insensitive to moderate changes in major operating parameters and to short-term increases in influent activity levels. (See also W88-00963) (Lantz-PTT)
W88-00986

ANAEROBIC TREATMENT OF DAIRY WASTES USING FIXED-FILM AND WITHOUT-MEDIA REACTORS,
Korea Univ., Seoul (Republic of Korea). Dept. of Civil Engineering.
E. Choi, and C. E. Burkhead.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 223-233, 14 fig, 4 tab, 11 ref.

Descriptors: *Anaerobic treatment, *Dairy industry, *Fixed-film reactors, *Wastewater treatment, Sludge, Chemical oxygen demand, Organic loading, Suspended solids.

This study was conducted to determine the anaerobic treatability of a synthetic industrial waste using laboratory batch reactors and to investigate the effects of plastic medium and temperature upon process efficiency. Also, the results obtained from the batch media units were compared with the results obtained from a laboratory continuous media unit. The units using plastic media can be classified as fixed-film anaerobic reactors, and the units operated without media are referred to as sludge blanket or contact type of reactors. The results of this study indicate that the without-media unit produced higher COD removal, even at higher organic loading rate, than the fixed-film unit. Generally, the COD removal efficiencies gradually decreased as the organic loadings increased, but the efficiencies declined rapidly beyond a certain organic loading rate. The maximum applicable organic loading rates were 5 kg COD/cu m/day for fixed-film and 7 kg COD/cu m/day for without-media units, respectively. The continuous fixed-film unit improved the COD removal efficiency but not as high as the without-media batch unit. The maximum organic loading rate of the continuous unit approached the maximum rate obtained from the batch fixed-film unit. The batch units did not show any filamentous growth, but the continuous unit had significant filamentous growth. The maximum organic loading rate and food to mass ratio for the room temperature fixed-film unit were about 1.3 kg COD/cu m/day and 0.11 to 0.15 kg COD applied kg M/day. The thermophilic unit showed higher COD removal efficiency; however, its operation was inhibited by the accumulation of volatile acids in the system. In summary, the over-all results of the fixed-film and without-media anaerobic units indicate that influent COD concentrations of 2,000 to 4,000 mg/L could be treated without any problem at a one day hydraulic detention time and with more than 90% COD removal efficiency. (See also W88-00963) (Lantz-PTT)
W88-00987

DAIRY WASTE TREATMENT USING INDUSTRIAL-SCALE FIXED-FILM AND UPFLOW SLUDGE BED ANAEROBIC DIGESTERS: DESIGN AND START-UP EXPERIENCE,
National Research Council of Canada, Ottawa (Ontario). Div. of Biological Sciences.
R. Samson, B. Van den Berg, R. Peters, and C. Hade.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 235-241, 3 fig, 4 tab, 5 ref.

Descriptors: *Dairy industry, *Wastewater treatment, *Sludge digestion, *Anaerobic digestion, Downflow station fixed-film reactors, Upflow sludge bed reactors, Industrial wastewater, Organic loading, Chemical oxygen demand.

Increasingly stringent environmental regulations coupled with rapidly rising energy costs make anaerobic digestion the preferred process for the treatment of soluble dilute waste. Treatment of dairy waste using advanced anaerobic digesters has been successfully used at laboratory scale. Reactors studied included the upflow sludge bed and contact process reactors and the fixed-film reactor from Canada. All these new technologies have in common the capacity to work at a high loading rate and high removal efficiencies because they have the ability to retain high concentrations of active biomass. Loading rates of 7 to 30 kg COD/cu m/day and COD removal efficiencies of 60 to 97% have been reported. Also, methane production rates as high as 5 cu m (STP)/cu m/day were possible. This paper deals with the technical or economical feasabilty of using these reactors for the treatment of cheese factor dilute effluent and methane production on an industrial scale. The discussion focuses on the design and utilization of two types of individual scale advanced anaerobic digesters, the downflow stationary fixed-film (DSFF) reactor and the upflow sludge bed (USB) reactor (400 cu m each). These reactors form the major piece of a complete wastewater treatment facility for the treatment of wastewater from a cheese factory in Notre-Dame-Du-Bon-Conseil, Quebec, Canada. A description of the complete wastewater treatment plant, and results obtained during the first year of operation are presented. Results indicate that the DSFF reactor is more suitable for handling larger variations in loading rates caused by waste strength and composition (milk fat) than the USB reactor. However, during proper operation, the USB reactor could handle larger steady-state loading rates with a higher COD reduction efficiency. As a result, it produced more biogas. (See also W88-00963) (Lantz-PTT)
W88-00988

TREATMENT OF SOFT DRINK BOTTLING WASTEWATER FROM BENCH-SCALE TREATABILITY TO FULL-SCALE OPERATION,
Northeastern Univ., Boston, MA. Dept. of Civil Engineering.
F. C. Blanc, J. C. O'Shaughnessy, S. H. Corr, and P. M. Smith.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 243-255, 5 fig, 8 tab, 1 ref.

Descriptors: *Wastewater treatment, *Food processing industry, Biological treatment, Nitrogen, Phosphorus, Bacteria, Activated sludge, Aerated lagoons, Economic aspects, Sludge lagoons.

When a soft drink bottling plant on Cape Cod decided to construct a new bottling plant in Sandwich, Massachusetts, a wastewater treatment and disposal system was required by the Commonwealth of Massachusetts since there was no munic-

ipal sewer system available. This paper presents the treatability investigation, design, and construction of the wastewater facility for this soft drink bottling plant. Average wastewater flow for the high production period was projected, based on production records for Jul, 1982, to be on the order of 11,000 to 12,000 gpd. The projected maximum daily flow can be expected to be approximately 26,000 gpd. On a production unit basis, the wastewater generated prior to the enactment of the Commonwealth's bottle deposit law was generally in the 1.0 to 1.4 gallons of wastewater/gallons of product range. Wastewater from soft drink bottling plants can be treated by biological treatment. In general, nutrient addition is required to provide sufficient nitrogen and phosphorus for the bacteria to utilize the amount of organic carbon in the waste. For this facility, three aerobic treatment options - activated sludge, rotating biological contactor, and aerated lagoon - were considered. A two-sate aerated facultative lagoon system was selected from the following reasons: (1) Equalization basin(s) are not required to dampen the flow and waste variations; (2) Economical to construct; (3) Economical to operate as the system does not require full-time operation and maintenance and little operator expertise is required; (4) Minimal sludge handling as sludge settles to the bottom of the lagoons and decomposes; (5) The system has high reliability and a service life of 30 years or more; and (6) The two-stage lagoon and infiltration basin system provides the flexibility to remove one unit from the operation to service it for sludge removal and/or bottom cleaning while maintaining bottling plant operations and avoiding costly shutdowns. (See also W88-00963) (Lantz-PTT)
W88-00989

PERFORMANCE MONITORING PROGRAM - MOLSON'S BREWERY DEEP SHAFT TREATMENT SYSTEM,
Le Clair (B.P.) and Associates, Barrie (Ontario).
B. P. Le Clair.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 257-268, 8 fig, 5 tab, 13 ref.

Descriptors: *Wastewater treatment, *Wastewater pretreatment, *Molson's Brewery, *Waste treatment, Performance evaluation, Ontario, Costs, Design standards, Sludge digestion.

Increased surcharges for the treatment of industrial effluents at municipal treatment works has resulted in many industries considering pretreatment as the most economical method for controlling wastewater pollution. In 1971, Molson Ontario Breweries Ltd. in Barrie, Ontario commissioned an extended aeration wastewater treatment plant to pretreat 4000 cu m/day of high strength readily biodegradable brewery wastewater. The effluent was treated in accordance with the City pretreatment bylaw which requires an effluent discharge from the brewery not exceeding 300 mg/L of TBOD5 and 350 mg/L TSS. Increasing brewery production, rising energy costs, and the urban location of its breweries necessitated investigation of treatment alternatives which were more energy and space efficient. The potential of the Deep Shaft effluent treatment process to fulfill these requirements of reduced energy and space requirements provided a major incentive to pilot this technology in Barrie. Other advantages claimed for the process were a lower capital cost and a reduced sludge production when compared with conventional technology. Following positive pilot studies and process design completion, plant construction began on January 3, 1980. In July, Eco Research commenced plant optimization and acceptance testing. Upon completion of these studies a two-year long extended performance monitoring program was carried out by Molson personnel. This paper reports on the data obtained during the monitoring program. (See also W88-00963) (Lantz-PTT)
W88-00990

TREATMENT OF EMULSIFIED AND COLLOIDAL INDUSTRIAL WASTEWATER USING A COMBINED ULTRAFILTRATION - CARBON ADSORPTION PROCESS,
ARATEX Services, Inc., Encino, CA.
G. J. Van Gils, M. Pirbazari, S.-H. Kim, and J. Shorr.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 269-280, 15 fig, 7 tab, 9 ref.

Descriptors: *Wastewater treatment, *Filtration, *Water reuse, *Emulsifiers, *Colloids, *Ultrafiltration, *Carbon, *Adsorption, Industrial wastewater, Laundering, Costs, Lime, Organic carbon, Bentonite.

A wastewater treatment process provides for comprehensive treatment of heavily soiled industrial laundry wastewater. The resulting product water quality is satisfactory for reuse in the laundry, and treatment operating costs are lower than the existing state-of-art wastewater treatment and disposal schemes. Optimum pretreatment for laundry wastewater prior to ultrafiltration was found to be lime coagulation at a dosage of 1,800 to 2,200 mg/L followed by sedimentation. Bench-scale tests using the combined ultrafiltration and powdered activated carbon adsorption system resulted in product water TOC values of 20 40 mg/L, typically, which was satisfactory for reuse in the industrial laundry. Ultrafiltration flux rates were decreased by high influent TOC concentrations, presumably due to unadsorbed organics. For this reason, efficient pretreatment and carbon adsorption is critical to the system's overall performance. Filter aids can be effective in the combined ultrafiltration/carbon adsorption system resulting in enhanced flux rates. Bentonite may offer a potential low cost alternative to powdered carbon for use with the ultrafiltration process. The pilot plant performance was commensurate with laboratory test results. TOC was removed over 90%, and flux rates averaged 130 GFD with a maximum of 260 GFD. (See also W88-00963) (Lantz-PTT)
W88-00991

TREATMENT OF LAUNDRY WASTEWATER FROM A NUCLEAR POWER PLANT BY REVERSE OSMOSIS,
National Taiwan Univ., Taipei.
F.-T. Jenq, and C.-J. Shih.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 281-290, 11 fig, 3 tab, 10 ref.

Descriptors: *Wastewater treatment, *Laundering, *Reverse osmosis, *Nuclear powerplants, Salt, Saline water, Radioactive wastes.

Reverse osmosis (RO) has been used in the chemical, food processing, pharmaceutical industries, and sea water desalination for many years. Also, this process has been applied in the treatment of industrial waste such as electroplating, pulp spent liquor, wastewater reclamation, oily wastewater, and electronic waste. There are two general applications of RO. One is the production of clean water; the other is a salt concentrate. Drinking water or valuable salts was be recovered from a waste solution by RO. However, in applying RO for the treatment of laundry wastewater from a nuclear powerplant, concerns are about both the 'permeate' and 'retentate'. Required is not just a clean permeate without radioactive hazard, but also a minimum volume of concentrate containing radioactive species in order to treat and to dispose it easily. Due to large volume and low radioactive strength in the laundry wastewater, it is necessary to study how to reduce its volume. The preliminary results of a three year project are given here; the experiments are still being conducted. From the data obtained, it is known that RO can concentrate the low strength wastewater. It can be used in volume reduction for laundry wastewater from nuclear powerplants. However, there are still many problems necessary to be investigated such as biological fouling, membrane cleaning techniques, and raw wastewater pretreatment. (See also W88-00963) (Lantz-PTT)
W88-00992

BIOLOGICAL TREATMENT REQUIRED FOR CLEANUP OF CONTAMINATED GROUND WATER AT A HAZARDOUS WASTE DUMP SITE,
Environmental Engineering Consultants, Inc., Stillwater, OK.
E. L. Stover, D. F. Kincannon, and T. S. Manickam.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 291-303, 2 fig, 11 tab, 7 ref.

Descriptors: *Water pollution treatment, *Wastewater treatment, *Cleanup operations, *Water quality control, *Biological treatment, *Groundwater quality, *Gilson Road, *New Hampshire, *Hazardous wastes, Disposal sites, Activated sludge, Aerated lagoons, Biological oxygen demand, Organic carbon, Phenols, Clarification.

The New Hampshire Water Supply and Pollution Control Commission has been directing efforts to contain and cleanup the Gilson Road Hazardous Waste Site in Nashua, New Hampshire for several years. Funding by the U.S. Environmental Protection Agency under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund) provided for a comprehensive containment and cleanup feasibility assessment which was completed in January 1982. Biological treatability studies conducted with activated sludge, aerated lagoon, and rotating biological contactor systems, indicated that the high temperature air stripper extract was very highly biodegradable. The BOD5, COD, and TOC contents of this water could be treated to high levels with BOD5 removal efficiencies of 98% to 99% readily achievable. The desired effluent qualities of BOD5:SS of 30:30 and 20:20 corresponding to soluble effluent BOD5's of 15 and 10, respectively, could be obtained by any of the three systems when designed properly. Total phenols and the extractable organics of concern were also very readily removed with high levels of efficiency in these biological systems. Volatile organics were not detected in the stripper extract. Heavy metals were not analyzed due to the excellent performance of the metals removal pilot plant. The design clarifier overflow rate was determined to be around 400 to 500 gpd/sq ft for all three systems. This should be a conservative overflow rate; however, for reliable attainment of < 30 mg/L effluent SS gravity settling alone may not be adequate. If design for < 30 mg/L effluent SS is required, polymer addition facilities should be provided in the design for all of the three alternatives evaluated. As previously shown, any of the three systems could be designed to achieve high treatment performance and good effluent quality. These three alternatives should be evaluated in terms of reliability, flexibility, process control, operational problems, simplicity of operations, and economics. The activated sludge system design was chosen as the selected alternative for the Gilson Road Site. The designs have been completed and approved by the State and EPA. (See also W88-00963) (Lantz-PTT)
W88-00993

EFFECTS OF CD AND CU ON A BIOFILM TREATMENT SYSTEM,
Missouri Univ.-Rolla. Dept. of Civil Engineering.
S.-Y. Chang, J.-C. Huang, and Y.-C. Liu.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 305-312, 5 fig, 2 tab, 18 ref.

Descriptors: *Water pollution effects, *Heavy metals, *Wastewater treatment, *Copper, *Cadmium, *Biological treatment, Organic carbon, Rotating biological contactor, Activated sludge.

The effect of Cd and Cu on the soluble organic carbon (SOC) removal efficiency in a fixed-film rotating bed contactor (RBC) system was evaluated in this study. Different levels of Cd (5 and 20 mg/) and Cu (1, 5, 10, 25, and 50 mg/L) were sequentially spiked in a 300 mg/L sugar solution in a shock load manner with times allowed for biological recovery. The first introduction of 5 mg/L of Cd for one day to the RBc system had a similar effect on the SOC removal efficiency as the spik-

ing of 20 mg/L for three days after the system recovered from its first Cd loading. The suppression of the SOC removal efficiency was 8% in both cases. The SOC removal efficiency in the RBC system was not affected when 10 mg/L or less Cu was spiked for 8-10 days. The suppression of the SOC removal efficiency was observed to be 7-10% when the Cu concentration was increased to 25 and 50 mg/L. Both Cd and Cu were also effectively retained by the biofilm. The average metal reduction varied from 85 to 95% for Cd, and 30 to 90% for Cu depending on the metal concentration in the feed solution. The toxicity effects of Cd and Cu to the RBC and the activated sludge systems were much the same. However, in the activated sludge system, the biological sludge became difficult to settle when Cu was present. (See also W88-00963) (Lantz-PTT)
W88-00994

CASE STUDIES INVOLVING THE TREATMENT OF HAZARDOUS SUBSTANCES UNDER THE SUPERFUND REMEDIAL ACTION PROGRAM,
Environmental Protection Agency, Washington, DC. Remedial Response Control.
W. M. Kaschak, and J. J. Spatarella.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 313-320, 2 fig, 2 tab, 3 ref.

Descriptors: *Waste disposal, *Water pollution treatment, *Case studies, *Hazardous wastes, *Superfund, *Cleanup operations, *Regulations, Legislation, Costs, Disposal sites, Water quality control, New Hampshire.

The U.S. Environmental Protection Agency (EPA) initiated the Superfund Program upon the passage of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The Superfund Program operates under the guideline of the National Contingency Plan (NCP). The NCP was published on July 16, 1982 and expanded to provide new Federal authority to respond to the problems at abandoned or uncontrolled hazardous waste disposal sites. The NCP outlines three categories of response actions: immediate removals, planned removals, and remedial response actions. Remedial response actions are intended to achieve solutions consistent with permanent remedy at uncontrolled hazardous waste disposal sites. The NCP identifies three types of remedial response actions which are based upon the complexity, immediacy, and extent of the hazards: (1) initial remedial measures, (2) source-control, and (3) off-site remedial actions. Initial remedial measures are appropriate when the actions to be taken are limited in nature and require a minimum of planning. The source-control and off-site remedial actions are more complex and require more extensive engineering evaluation to select the most cost-effective solutions. An initial remedial measure is being implemented at the Bridgeport Rental and Oil Services site in New Jersey which involves the treatment and disposal of the aqueous phase of an 11.8-acre lagoon. Source-control remedial action is being implemented at the Sylvester site in New Hampshire in two phases. The first phase involved the installation of a slurry wall and cap. The second phase will include the extraction and treatment of highly contaminated groundwater within the containment system. The planning activities and engineering studies leading up to the selection of the treatment systems at these two sites are discussed. (See also W88-00963) (Lantz-PTT)
W88-00995

BIOLOGICAL TREATMENT OF A BRINE GROUNDWATER CONTAMINATED WITH HIGH CONCENTRATIONS OF ORGANICS,
DETOX, Inc., Dayton, OH.
E. K. Nyer, and R. E. Sauer.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 321-328, 12 fig, 4 ref.

Descriptors: *Biological treatment, *Water quality control, *Wastewater treatment, *Groundwater quality, *Water pollution treatment, *Organic compounds, Wells, Activated sludge, Water pollution control, Filtration, Organic carbon.

A shallow, saline, non-potable saturated zone consisting of silty sand was contaminated under a hazardous waste management facility when a pond liner was punctured by construction equipment during a cleaning operation. For wells placed in a shallow silty sand layer, eductors will be more efficient than submersible pumps. Although there are maintenance problems associated with the eductors, they are not as labor intensive as the submersible pumps. French drains and re-injection pits can be used to quickly alter a groundwater flow pattern. The full-scale treatment system design included the following: a first-stage activated sludge system, a second-stage fixed film/activated sludge system, a dual media filter, and a carbon adsorption column. This system was economical and could easily be changed to reflect the changes in the influent concentration. After overcoming salt inhibition and low nutrient concentration, the pilot plant was able to consistently remove 70% of the influent TOC. Site personnel with no previous water treatment experience can be trained to operate a biological system. (See also W88-00963) (Lantz-PTT)
W88-00996

CHARACTERIZATION AND TREATABILITY STUDIES OF AN INDUSTRIAL LANDFILL LEACHATE (KIN-BUC I),
Rutgers - The State Univ., Piscataway, NJ.
D. S. Kosson, E. A. Dienemann, and R. C. Ahlert.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 329-341, 8 fig, 5 tab, 12 ref. OWRT Contract No. CR807805010.

Descriptors: *Cleanup operations, *Waste treatment, *Landfills, *Industrial wastes, *Kin-Buc, *New Jersey, *Leachates, *Water pollution treatment, *Waste disposal, Oils, Polychlorinated biphenyls, Biodegradation, Anaerobic treatment, Aerobic treatment, Organic carbon.

The Kin-Buc Landfill, located in Edison, New Jersey, received approximately 70,000,000 gallons of diverse industrial and chemical wastes between 1971 and 1979. This landfill is configured as a hillifill. In 1979, leachate was discovered to be percolating from the landfill. The leachate is a multiphase mixture comprised of a bulk oil phase and a bulk aqueous phase containing dispersed oil and particulate phases. Three experiments were conducted to study the effectiveness of the proposed treatment process (sequential aerobic and anaerobic biodegradation in a soil column): (1) Experiment 0182 tested the proposed process using 3-inch diameter laboratory soil columns; (2) Experiment 0682 extended the results of Experiment 0182 to field scale; and (3) Experiment 0183 examined the effect of feed leachate concentration on treatment effectiveness. Flux rates, TOC reductions, and percent changes from Experiment 0682 to Experiment 0683 are summarized in tables. Several conclusions can be reached from Experiment 0683. Reduced influent leachate concentrations resulted in an increased incidence of system plugging. This is in consonance with results obtained in Experiment 0682. Removal of glucose from the feed had no apparent effect on system permeability. Peaks in effluent TOC, in response to adaptation in the presence of leachate in the feed, were shorter in duration and smaller in peak magnitude than those in Experiment 0682 or Experiment 0183. This is probably the result of a residual acclimated microbial population remaining in the soil from Experiment 0682. The removal of glucose from the feed had no apparent effect on TOC reduction. Organic carbon reduction by adsorption was most likely not very significant in Experiment 0683. Reductions in excess of 90% were still obtained. (See also W88-00963) (Lantz-PTT)
W88-00997

ARSENIC SLUDGE DEWATERING,
Beak Consultants Ltd., Mississauga (Ontario).
R. W. Wilson, K. L. Murphy, and J. C. Ramshaw.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 343-351, 1 fig, 6 tab, 5 ref.

Descriptors: *Arsenic, *Wastewater treatment, *Sludge drying, Chemical treatment, Solidification, Fixation, Costs, Freeze-thaw tests, Filtration, Clarification.

The Ontario Ministry of the Environment (MOE) operates a water pollution control plant to remove arsenic from contaminated leachate at the site of an abandoned gold mining and refining complex at Deloro, Ontario. Currently chemical sludge produced during the treatment process is pumped to storage basins. Described here is bench and pilot scale work completed to develop an optimum process for the dewatering and the ultimate disposal of the arsenic sludge. Conventional mechanical dewatering, chemical fixation/solidification and dewatering by freeze-thaw techniques were investigated. The filter press process was found to be the best conventional process option for dewatering the calcium ferro-arsenate sludge produced at Deloro. Filtration rates were low due to the very high specific resistance of the sludge, thus requiring longer filter cycles and a relatively low design throughput. The addition of 5% cement kiln dust based on total wet clarifier sludge quantities increased filterability sufficiently to produce cakes of 30% solids and higher using 25 mm thick plates in a filtration time of 2.0 to 2.5 hours. Freeze-thaw dewatering of the sludge was proven to be technically feasible at the Deloro site and preliminary indications were that it could be economically attractive. The freeze-thaw process increased sludge consistency from 5% to 50% solids transforming the sludge into a granular, well draining residue. (See also W88-00963) (Lantz-PTT)
W88-00998

DESTRUCTION OF PCB CONTAMINATED FUEL OIL IN AN ALUMINUM MELTING FURNACE,
Aluminum Co. of America, Davenport, IA.
M. K. Sonksen, and S. P. Busch.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 353-359, 3 fig, 3 tab.

Descriptors: *Polychlorinated biphenyls, *Fuels, *Aluminum, *Industrial wastes, *Waste treatment, *Waste disposal, Hydraulic fluids, Costs, Energy, Oil.

Like most industries that have high temperature operations, Alcoa's Davenport Works requires hydraulic fluids that have the ability to maintain physical properties at high temperature and that provide maximum protection against fire. From about 1960 to 1972, an additive in these fluids was polychlorinated biphenyls (PCB's). In early 1979, when environmental concerns surfaced regarding the use of fluids containing PCB in concentrations over 50 mg/L, Davenport Works environmental engineering department initiated a comprehensive survey of the hundreds of hydraulic systems throughout the plant. Only a handful of the systems were found to contain residual PCB over 50 mg/L. In 1979, as today, there were limited options for the proper disposal of PCB contaminated liquids. An option of interest was the regulatory authority (40) CFR 761.60 (e) of each EPA Regional Administrator to approve an alternate disposal method if sufficient PCB destruction efficiency could be achieved. To investigate the viability of this option, and since one melting furnace had not yet been converted back to gas, Davenport Works speedily conducted four PCB emission tests on a melter exhaust stack on June 26 and 27, 1979. These tests indicated an average PCB destruction rate of 99.82%. Use of the oil in a production facility in an environmentally safe manner. This process has several significant benefits. These include energy conservation with an overall savings of 2.3 times 10 to the 11th BTUs and the environmental benefit of destruction of the PCB. The process also eliminates the hazards of transport over long distances. Last, but not least, is the

$2,500,000 savings to be realized by using the contaminated oil. (See also W88-00963) (Lantz-PTT)
W88-00999

NEW TYPE OF ANAEROBIC DESIGN FOR ENERGY RECOVERY AND TREATMENT OF LEACHATE WASTES,
Black and Veatch, Kansas City, MO.
J. L. Carter, G. M. Curran, P. E. Schafer, R. T. Janeshek, and G. C. Woelfel.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 369-376, 3 fig, 8 tab, 6 ref.

Descriptors: *Water pollution treatment, *Waste disposal, *Wastewater treatment, *Anaerobic treatment, *Energy, *Leachates, Landfills, Filtration, Biological oxygen demand, Suspended sediments, Hydraulic retention time, Calcium, Magnesium, Heavy metals, Alkalinity, Carbonates.

The Omega Hills landfill, operated by Waste Management, Inc. (WMI), is located 15 miles northwest of downtown Milwaukee, Wisconsin. The landfill accepts municipal, industrial, and commercial wastes at daily rates ranging from 5,000 to 10,000 gate cu yd/day. In the past, the 83 acre landfill accepted liquids and sludges for co-disposal, utilizing the absorptive capacity of the refuse. Waste Management is currently extracting leachate from these systems. in addition, it has developed and implemented supplemental leachate extraction utilizing vertical caissons drilled to the base of the site and equipped with well screens and automatic extraction pumps. Leachate withdrawn from the landfill is pumped to 5,500 gallon tank trucks and discharged through a drop inlet to a sewer leading to the Milwaukee Metropolitan Sewerage District (MMSD) South Shore Treatment Plant. The Wisconsin Department of Natural Resources (WDNR) requested that WMI provide a treatment system for the leachate by the fall of 1984. WMI has decided to initially build one digester, an anaerobic filter. Measures to control solids were investigated so that this single stage of treatment will achieve maximum removals of both BOD and SS. It was found that: (1) WMI leachate is easily treated by anaerobic digestion; (2) 80% or better total BOD removals are possible in anaerobic filter; (3) Approximately the same BOD removals are obtained with cross flow media as with vertical flow media; (4) Preliminary results indicate a design basis of 5.5 days HRT or a BOD loading of 500 lb/d/1000 cu ft of media; and (5) Ca, Mg, and heavy metals precipitate in digester as carbonate alkalinity becomes available from metabolism of volatile acids. (See also W88-00963) (Lantz-PTT)
W88-01001

VOLUME REDUCTION OPTIONS FOR INSTITUTIONAL RADIOACTIVE WASTES,
Bechtel Corp., Oak Ridge, TN.
H. A. Bryson, D. W. Weeter, T. W. Oakes, and B. M. Eisenhower.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 377-384, 2 fig, 2 tab, 18 ref.

Descriptors: *Waste treatment, *Radioactive wastes, *Oak Ridge National Laboratory, *Waste disposal, *Waste management, Chemical wastes, Incineration, Chemical treatment, Adsorption, Potassium permanganate, Lime, Portland cement.

Biological radioactive wastes (BRW) and their treatment were studied for the Oak Ridge National Laboratory (ORNL) by the University of Tennessee (Knoxville) Department of Civil Engineering. One objective of this study was the investigation into, and recommendation of, viable waste management options for the BRW generated by the ORNL Biology Division. The principal hazard characteristics from a practical standpoint were the chemical and infectious ones. All existing TSD methods commonly employed for institutional radioactive waste were evaluated. During FY83, there were on the order of 200 personnel working in the Biology Division laboratory groups, conducting 35-40 experiments, and utilizing 27 waste collection stations. These stations usually had separate containers for the Liquid, Dry, and Scintillation Counting Wastes. Modification of waste generation and collection activities was considered, but was found to be inappropriate with respect to the primary study recommendations due to the number, diversity, and transitory nature of the individual research projects. Suitable TSD recommendations had to be capable of coping with any waste forms generated. The methods presented in this paper have the capability and flexibility to satisfy this condition. Some of these options are: (1) chemical treatment with potassium permanganate, dehydrated lime and/or Portland cement; (3) Adsorption; and (3) Incineration. (See also W88-00963) (Lantz-PTT)
W88-01002

TREATMENT OF HAZARDOUS WASTES IN A SEQUENCING BATCH REACTOR,
CECOS International, Inc., Buffalo, NY.
P. A. Herzbrun, M. J. Hanchak, and R. L. Irvine.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 385-393, 6 fig, 9 tab, 3 ref. NY State Energy and Development Authority Contract No. 601-CON-IC-84.

Descriptors: *Wastewater treatment, *Wastewater facilities, *Sequencing batch reactors, *Hazardous wastes, New York, Hydraulic retention time, Phenols, Organic carbon, Biodegradation, Phosphorus, Costs, Economic aspects.

The CECOS International Wastewater Treatment Plant in Niagara Falls, New York is one of the only two fully permitted treatment, storage, and disposal facilities in New York State. It treats both leachates from industrial landfills and industrial wastes shipped either in bulk or drums. The wastewater treatment system typically receives 9,460-11,260 cu m/month. Approximately 50% of this is leachate pumped from both active and inactive landfills on the CECOS site; approximately 30% is pumped as part of a remedial groundwater program from an unrelated facility bordering the CECOS site, and the remaining 20% is received in bulk or drums from various industries in a 640 km radius. In late 1982 CECOS decided to upgrade its treatment system. As a result of the pilot-plant studies, a full-scale demonstration facility was designed and modified. Four SBR reactors were operated at room temperature for a two month period. Retention times varied from 10 days down to 1.25 days. TOC degradation ranged from 55 to 81%, and phenol degradation ranged from 96.8 to 99.2%. Both ranges easily result in effluent concentrations that are below permit limits. Oxygen uptake rates and spiking studies indicate that the wastewater is readily biodegradable and that larger volumes of water can be handled in the full-scale reactor during peak periods. Sufficient phosphorus was present in the raw wastewater, and foaming should be easily controlled with bubble breaking compounds. A one or two day power failure should have no short or long term effect on system performance. The function of activated carbon will be shifted from one of primary organic removal to a more cost effective polishing role. Associated with this will be a significant energy savings based on fewer carbon loads being regenerated. (See also W88-00963) (Lantz-PTT)
W88-01003

RAPID INDUSTRIAL WASTE SCREENING METHOD,
Chattanooga, TN.
For primary bibliographic entry see Field 5A.
W88-01004

WET EFFLUENTLESS FLUE GAS CLEANING SYSTEM ON A REGIONAL CHEMICAL WASTE INCINERATION AND ENERGY RECOVERY SYSTEM IN BIEBESHEIM, GERMANY,
Environmental Elements Corp., Baltimore, MD. Waste Disposal Systems Group.
W. G. Leedy.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 407-412, 3 fig, 1 tab.

Descriptors: *Flue gas cleaning, *Chemical wastes, *Waste treatment, *Incineration, *West Germany, *Biebesheim, Halides, Wastewater treatment.

Cleaning flue gases from waste combustion processes has received increasing attention both in the United States and in Europe during recent years. As a result, a number of new flue gas cleaning technologies have been developed. One such new technology was developed during the mid 1970's by CIBA-GEIGY in Switzerland. The system which utilizes this technology consists off a spray dryer reactor vessel in which scrubber effluent is evaporated and the flue gas is cooled, followed by a cyclone in which the larger particles are separated from the flue gas, followed by a low pressure venturi quench in which the flue gas is cooled to the saturation point, followed by a packed bed counter flow scrubber in which hydrogen halides are removed from the flue gas and, finally, followed by a series of small medium pressure venturi scrubbers in which submicron particles and sulfur oxides are removed from the flue gas. This flue gas cleaning technology is often referred to as a spray dryer technology. However, a more accurate title is a wet effluentless flue gas cleaning technology. There are three principal benefits to this new flue gas cleaning technology. First, it has excellent submicron particle removal efficiency which is achieved with significantly less energy consumption than traditional high pressure venturi technologies. Second, the high submicron particle removal efficiency and the advantages of wet scrubbing are achieved without producing a wet effluent that often must be treated before it is discharged. Third, it uses less water than most other wet scrubbing technologies. The remainder of this paper is dedicated to a brief description of HIM, its facility in Biebesheim, Germany, the CIBA-GEIGY wet effluentless flue gas cleaning technology, and the operating experience gained during the first two years of operation of the first application of this new technology. (See also W88-00963) (Lantz-PTT)
W88-01005

PACT WASTEWATER TREATMENT FOR TOXIC WASTE CLEANUP,
Zimpro, Inc., Rothschild, WI. Research and Development Dept.
P. J. Canney, C. J. Mordorski, R. M. Rollins, and C. L. Berndt.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 413-428, 10 fig, 8 tab, 13 ref.

Descriptors: *PACT, *Powdered activated carbon treatment, *Wastewater treatment, *Toxic wastes, *Cleanup operations, Oxidation, Industrial wastes, Activated carbon, Chemical oxygen demand, Biodegradation, Biological oxygen demand, Organic compounds.

PACT wastewater treatment and wet air oxidation provide effective treatment of dilute and high strength toxic and hazardous industrial wastes. The combination of these processes enable treatment of a wide range of toxic wastes. Described is the application of wet air oxidation for pretreatment of a mixed hazardous waste that is then subjected to PACT treatment to produce a water quality suitable for direct discharge. Wet air oxidation of a high strength industrial waste mixture resulted in significant reductions in COD and chlorinated organic compounds and enhancement of biodegradability. Oxidation of the wastewater spiked with compounds contributing as high as 7000 mg/L organic chlorine resulted in destruction of the added compounds in the 83 to 99+% range with most in the 98 to 99% range. Wet air oxidation of the high strength waste mixture followed by PACT treatment of the oxidized product resulted in exceptionally high COD, BOD, and organic chlorine removals. Overall removals of 98+, 99+% were observed for COD, BOD, and EOCl,

respectively, by wet air oxidation/PACT treatment. PACT system effluent EOCl values were less than 0.05 mg/L at feed EOCl levels as high as 150 mg/L. Based on the results of this study, PACT wastewater treatment was selected and design of the full scale system is underway. (See also W88-00963) (Lantz-PTT)
W88-01006

SMALL-SCALE FIELD EVALUATIONS OF LAND TREATMENT OF AN OILY HAZARDOUS WASTE,
Robert S. Kerr Environmental Research Lab., Ada, OK.
F. M. Pfeffer, G. Myers, R. C. Loehr, and D. F. Kincannon.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 439-445, 1 fig, 9 tab, 6 ref.

Descriptors: *Path of pollutants, *Field studies, *Case studies, *Land disposal, *Cleanup operations, *Waste disposal, *Oils, Hazardous wastes, Oklahoma, Waste storage, Chemical analysis, Alkanes, Organic compounds, Heavy metals.

Beginning in 1980, the EPA provided technical assistance to Sun Refining and Marketing Company in Sun's efforts to renovate a waste disposal site at Mounds, Oklahoma near Tulsa. The Mounds site was a 130-acre improperly managed storage facility containing approximately 220,000 bbl of sludges thought to be predominantly of refinery origin. In 1980, the Mounds facility was a prime Superfund candidate for the State of Oklahoma because of the magnitude of the problem and because the State had not been able to force remedial action by the original owner/operator (not Sun). However, Sun volunteered as a 'friend of the Court' to clean up the site using land treatment as the predominant mechanism. Following implementation of full-scale land treatment, sampling and analysis revealed that specific organics (mostly alkanes) and heavy metals were concentrated predominantly in the plow zone. Continued sampling of the facility will be required in order to assess whether the pilot-scale findings are indicative of the full-scale results. (See also W88-00963) (Lantz-PTT)
W88-01008

POLLUTION PREVENTION PAYS (3P). 3M'S RESPONSE TO INDUSTRIAL WASTE CONTROL,
Minnesota Mining and Mfg. Co., St. Paul.
For primary bibliographic entry see Field 5G.
W88-01011

DEWATERING OF STEEL-MILL SLUDGES BY BELT-PRESS FILTRATION,
Nalco Chemical Co., Napeville, IL.
R. R. Patzelt, and D. E. Hassick.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 469-485, 9 fig, 9 tab, 7 ref.

Descriptors: *Wastewater treatment, *Belt-press filtration, *Sludge drying, *Steel industry, *Filtration, Polymers, Sludge.

One type of equipment that is not widely used for sludge dewatering in the steel industry is the twin-belt-press filter. In this type of filter, sludge is squeezed between two filter belts by sets of rollers that exert increasing pressure as the sludge passes through the unit. Belt-press filtration technology has been successfully applied to the dewatering of municipal sludges, various oil wastes (refineries, tanneries), and very abrasive wastes (coal-preparation plants). Little reference can be found however, to belt-press filtration of steel-mill sludges. Nalco Chemical Company and U.S. Steel Corporation have conducted a joint laboratory study to investigate belt-press filtration of steel mill sludges. Sludges representing most of the difficult to dewater types generated in steel mill operations (e.g., hot forming, cold rolling, lagoon) were sampled, characterized and bench tested for belt press filterability. As a further test of this concept, four different sludges were evaluated in sustained trials on a pilot twin-belt press. The results of this study have demonstrated the feasibility of dewatering steel mill sludges with a belt press. Batch test results gave good estimates of the cake solids and cake strength obtainable from the pilot press. Polymer consumption in these experiments was somewhat higher than the polymer consumption in the sustained trials. Sustained trials have demonstrated the effects of processing variables and the sludge character on the performance of the belt press. Furthermore, these trials have shown that blending of steel mill sludges can, in certain cases, improve the properties of the filter cake while reducing the polymer consumption. (See also W88-00963) (Lantz-PTT)
W88-01013

UPGRADING FOUNDRY WASTEWATER TREATMENT,
Rexnord, Inc., Milwaukee, WI. EnviroEnergy Technology Center.
R. Osantowski, and J. Ruppersberger.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 487-494, 3 fig, 7 tab, 3 ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Foundries, Iron, Dust, Slag, Cooling water, Wash water, Chemical treatment, Clarification, Filtration, Recycling, Wastewater reuse, Nutrients, Water quality, Temperature.

Primary wastewater generating operations in the ferrous foundry industry include: (1) dust collection; (2) melting furnace scrubber; (3) slag quenching; (4) casting quench and mold cooling; and (5) sand washing. The objective of this project was to determine the quality of treated iron foundry wastewater that could be achieved using chemical clarification and filtration technology. The project did not include evaluation of the technical feasibility of reusing wastewater of the quality produced by the pilot treatment system. The research work was performed at a large gray iron foundry with an average daily gross melt of 667 Mg (734 tons) and a wastewater flow of 8607 cu m/day (2.27 mgd). The typical water application rate during the 6 week investigation was 13 cu m of wastewater/1000 kg of gross melt (3105 gal/ton). The results of this study have shown that it is feasible to treat the gray iron foundry industry wastewater to a high quality using a treatment train consisting of chemical addition/clarification and filtration. To minimize foundry plant recirculation system problems, reclaimed water: (1) must not form scale on heat exchanger surfaces; (2) must not be corrosive to metal in the cooling system; (3) must not supply nutrients promoting the growth of slime-forming organisms; (4) must not foam excessively; and (5) must not cause the wood in cooling towers to deteriorate. (See also W88-00963) (Lantz-PTT)
W88-01014

RATIONALE FOR THE DESIGN OF A WATER TREATMENT FACILITY FOR A MODERN HOT STRIP MILL. OVERVIEW OF DESIGN,
Stelco, Inc., Hamilton (Ontario). Water Treatment Group.
H. K. Miyamoto, C. A. Perl, and J. N. Hilton.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 495-509, 6 fig, 9 tab, 11 ref.

Descriptors: *Water reuse, *Wastewater treatment facilities, *Hot Strip Mill, *Design standards, *Wastewater treatment, Industrial wastewater, Recirculation, Water pollution control, Wastewater reuse, Economic aspects, Costs, Wastewater lagoons, Temperature, Dissolved solids, Filtration.

Lake Erie Works is situated on 1660 hectares at Nanticoke, Ontario on the North Shore of Lake Erie approximately 70 km southwest of Hamilton. It is an integrated steelmaking facility with dock and raw material handling systems, a Coke Oven Battery, a Blast Furnace, Basic Oxygen Furnaces, a Slab Caster and a 2050 mm (80 inch) Hot Strip Mill. An investigation was conducted into the process requirements for a future Hot Strip Mill, the environmental requirements for discharge of the process water, and identification of the sources of contamination to that water. A design for a water treatment plant was made which satisfied these constraints using the following principles: recirculation and reuse of water as much as possible; reduction of contaminant at the source; minimizing capital and operating costs; and applying the latest technology. This resulted in a conceptual design with the following features: solids removed by a lagoon and high rate gravity filtration plant; heat removed by a cooling tower; dissolved solids removed by a combined filter backwash/blowdown scheme; and a forward and backward cascading water system which minimized water consumption and reduced operating and capital costs. (See also W88-00963) (Lantz-PTT)
W88-01015

IRON CONDITIONING OF SLUDGE FROM FOUNDRY FURNACE EMISSION CONTROL SYSTEMS FOR ELIMINATION OF EP TOXICITY,
Residuals Management Technology, Inc., Madison, WI.
W. A. Stephens, T. R. Stolzenburg, R. R. Stanforth, and J. E. Etzel.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 511-514, 6 fig, 3 ref.

Descriptors: *Iron, *Sludge conditioning, *Foundries, *Wastewater treatment, *Water pollution control, *Waste disposal, Toxicity, Sludge disposal, Lead, Cadmium, Landfills, Leaching.

In a study conducted by US EPA, approximately 40% of the sludges tested from foundry emission control wastes were classified as 'hazardous' using an EP Toxicity leaching test. In this test, lead and/or cadmium will typically leach at concentrations near or above US EPA's hazardous waste limits. Disposal of these solids in a hazardous waste landfill can be more expensive than treating the sludge to reduce Pb and Cd leaching. Various chemical additives have been used either on the wastewater or on the sludge after settling to immobilize the Pb and Cd. Investigators at Purdue University and Residuals Management Technology have experienced success with treatment of the waste using Fe. The results and discussion of some of the Fe tests are presented here. The tests clearly demonstrate that the addition of Fe to the furnace emission control wastes tested can reduce Pb leaching to below hazardous limits. Effective forms of Fe include: ferric sulfate, ferric hydroxide, and metallic Fe. Pb leaching from the sludge is probably decreased by a combination of mechanisms including: adsorption to ferric hydroxide, reduction of divalent Pb to solid Pb, and pH neutralization of the acetic acid. (See also W88-00963) (Lantz-PTT)
W88-01016

BIOLOGICAL REMOVAL AND CHEMICAL RECOVERY OF METALS FROM SLUDGES,
Toronto Univ. (Ontario). Dept. of Civil Engineering.
L. Wong, and J. G. Henry.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 515-520, 7 fig, 3 tab, 17 ref.

Descriptors: *Biological treatment, *Chemical treatment, *Heavy metals, *Wastewater treatment, *Sludge, *Waste disposal, Sludge digestion, Sludge drying, Centrifugation, Hydrogen ion concentration, Sludge disposal, Land disposal.

The role of thiobacillus ferrooxidans on metal solubilization from anaerobically digested sludge was confirmed in this study conducted on anaerobically digested sludge obtained from the Humber Wastewater Treatment Plant in Metropolitan Toronto. The efficiencies of metal solubilization were significantly reduced when the bacteria were inhibited either by sodium cyanide or pentachloro-

phenol. The efficiencies of metal solubilization from digested sludge by bacterial leaching decreased with increasing sludge solids concentration. Gentle mixing was found to be best for bacterial leaching. Inadequate or excessive mixing reduced the metal solubilization efficiencies. The leached sludge could be dewatered to more than 18% by centrifugation at 1100 G for 10 minutes with no polymer addition needed. More than 95% of the solubilized metals were separated from the sludge solids. The metal laden leachate treated with lime to a pH of 10 or above resulted in over 95% precipitation of metals. THe lime treated leachate could be recombined with the decontaminated sludge cake. The mixture has a pH of about 7.5 and can be used on land because the concentrations of heavy metals have been reduced to acceptable levels while the soil conditioning and fertilizing potential of the sludge was conserved. (See also W88-00963) (Lantz-PTT)
W88-01017

COST-EFFECTIVE WASTE MANAGEMENT FOR METAL FINISHING FACILITIES: SELECTED CASE STUDIES,
Radian Corp., Research Triangle Park, NC.
G. E. Hunt, and R. W. Walters.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 521-528, 6 fig, 2 tab, 7 ref.

Descriptors: *Wastewater management, *Metal-finishing wastes, *Case studies, *Cost-benefit analysis, *Wastewater treatment, Economic aspects, Water conservation, Water quality control, Drag-out.

Presented are some of the results of two studies into the application of cost-effective waste management techniques to metal finishing facilities within Maryland. This work was sponsored by the Maryland Hazardous Waste Facilities Siting Board. The Board recognized that many of the waste generators within the State did not have the technical capabilities to develop cost-effective waste management strategies. Thus, the Board investigated means by which industry could be provided with assistance on hazardous waste management. In these studies, selected metal finishing facilities were given detailed engineering and economic evaluations of waste management techniques applicable to their facilities. The methods were selected based on their cost and effectiveness in reducing wastewater and hazardous waste generation rates. The selection was based on inplant process evaluations and, if necessary, bench scale treatability studies. Methods discussed here are water conservation drag-out controls, and management of drag-out, with case studies from: a mid-sized electroplating job shop, a facility which manufactures a variety of plated and painted wire products, a circuit board manufacturer, and a mid-sized job shop serving a wide range of client needs. (See also W88-00963) (Lantz-PTT)
W88-01018

METAL RECOVERY FROM WASTE SLUDGES,
Recycle Metals, Glastonbury, CT.
C. S. Brooks.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 529-535, 1 fig, 4 tab, 8 ref.

Descriptors: *Wastewater treatment, *Heavy metals, *Sludge, *Metal recovery, *Metal-finishing wastes, *Recycling, *Waste disposal, Metal oxides, Nickel, Cobalt, Cadmium, Copper, Zinc, Sodium lauryl sulfate, Flotation, Chelation.

Waste metals in the form of metal oxide (hydroxide) sludges are generated in significant amounts by the metal finishing industries, and their accumulation pose problems for disposal and challenges for recycle. The availability of technically feasible efficient separations of metals such as nickel, cobalt, chromium, cadmium, copper, tin, zinc, lead, manganese, molybdenum, and titanium from plating, pickling, and electrochemical machining (ECM) waste sludges would achieve dual objectives: (1) recovery of strategic metals with significant economic value, and (2) minimization of solid waste disposal costs. Bench scale experimentation with actual and simulated waste metal (nickel, copper, zinc, and cobalt) has produced promising results for nonselective flotation separations with sodium lauryl sulfate (NLS) in combination with nonionic flocculants as a more efficient dewatering alternative to sedimentation, centrifugation, or filtration. Highly selective flotation separations of metals such as nickel have been obtained using specific chelation reactions, such as nickeldimethyl glyoxime in combination with NLS. (See also W88-00963) (Lantz-PTT)
W88-01019

ALGAE, ION EXCHANGE AND METAL FINISHING WASTES,
Clemson Univ., SC. Dept. of Environmental Systems Engineering.
F. J. Sloan, A. R. Abernathy, and J. C. Jennett.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 537-543, 3 fig, 5 tab, 24 ref. NSF Grant No. ISP-8014994.

Descriptors: *Algae, *Wastewater treatment, *Ion-exchange, *Metal-finishing wastes, *Biological treatment, Chlorella, Equilibrium, Chemical reactions.

The green algae Chlorella pyrenoidosa exhibits several interesting features with regard to its ability to sequester metal ions from solution. The equilibrium distribution of metal ions between the solution and algal cells is dependent upon total ionic strength of the solution as well as concentration of the metal ion. Plots of separation factors at different ionic strengths are better for describing the metal ion uptake than are Freundlich and Langmuir isotherms. Concentration factors also vary with total ionic strength of the solution as well as with the concentration of the metal ion in question. The presence and concentration complexing agents affect the equilibrium distribution of metal ions between the solution and the algal cells. The uptake of metals by an algal sludge is also dependent upon ionic strength. All of the above evidence suggests that the rapid uptake of metal ions by Chlorella pyrenoidosa and algal sludge is ion exchange, a physical mechanism independent of the cell's metabolism. Chlorella pyrenoidosa is best modeled as a weakly acidic cation exchange resin. (See also W88-00963) (Lantz-PTT)
W88-01020

INNOVATIVE DESIGN AND ENGINEERING OF A WASTEWATER PRETREATMENT FACILITY FOR A METAL FINISHING OPERATION,
Lockheed Electronics Co., Plainfield, NJ.
E. R. Ramirez, and O. F. D'Alessio.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 545-553, 3 fig, 3 tab, 5 ref.

Descriptors: *Wastewater pretreatment, *Design standards, *Wastewater treatment, *Pretreatment of wastewater, *Metal-finishing wastes, Economic aspects, Costs, Electrolysis, Heavy metals, Waste disposal.

This paper is directed specifically to pretreatment for the Electroplating and Metal Finishing Point Source categories. More specifically it addresses the engineering and design procedures applicable to industries with discharges of < 100,000 GPD. Job shoppers dominate this categorical industry and capital equipment costs are a serious deterrent to wastewater pretreatment because of the competitiveness of this industry in terms of profits and cash flow. The classical method of using chlorination and heavy metal hydroxide precipitation followed by filtration requires high capital costs, extensive instrumentation, high operating costs, and lastly, it requires a large operating space. This paper proposes new methods and concepts in order to cost-effectively meet the Effluent Limitations Guidelines for electroplaters and metal finishers. It was found that an electrolytic method of removing heavy metal pollutants from wastewater is inexpensive in terms of capital equipment and operating cost when the weight of pollutants are small, < 10 lbs/day/plant. Electrolytic methods of removing heavy metals do not generate hazardous or toxic by-products, thus reducing the costs of hauling away toxic and hazardous sludge. Electrolytic technology requires a minimum of space when compared to chlorination and hydroxide precipitation methods. Capital costs for electrolytic methods are low when compared to the conventional chlorination precipitation designs. (See also W88-00963) (Lantz-PTT)
W88-01021

MODELING OF ULTRAFILTRATION FOR TREATING FISHERY WASTEWATERS,
North Carolina State Univ., Raleigh. Dept. of Civil Engineering.
A. C. Chao, L. Tzou, and D. Green.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 555-563, 12 fig, 3 tab, 11 ref. U.S. Dept. of Commerce Grant No. NA83AA-D00012.

Descriptors: *Model studies, *Ultrafiltration, *Wastewater treatment, *Fisheries, Filtration, Mathematical models, Organic compounds, Costs, Molecular structure, Pore size.

A mathematical model for calculating the treatment efficiency of the ultrafiltration process for treating fishery processing wastewaters is based on a normal distribution of the molecular weights of the organic substances in the wastewater to be treated. Laboratory data were employed to verify the proposed model. For pure organic chemicals, a standard deviation of 0.3 should be used and for organic substances in fishery wastewaters, a standard deviation value of 0.6 should be used. A certain percentage of the organic substances in the wastewater is assumed to undergo hydrolysis forming amino acids or polypeptides of smaller molecular weights. Using the proposed model, the calculated results fit the laboratory data and can be employed to predict the treatment efficiency of the ultrafiltration process. Based on laboratory data, the model can be used to generalize the relationship between the treatment efficiency and the ratio of solute molecular weight to membrane pore size expressed as its molecular weight cut-off. Since the cost-effectiveness of ultrafiltration treatment is entirely dependent on the permeate flux rate, a higher permeate flux rate will result in a great saving in the annual operating cost. The permeate flux rate of a membrane is generally proportional to its pore size or molecular weight cut-off. Thus, it is necessary to select a membrane having the largest possible pore size without sacrificing the quality of the treated permeate. If the effluent quality using a certain membrane pore size exceeds the limitations of the effluent that can be discharged, the membrane having the next greater pore size or molecular weight cut-off can then be considered to achieve a higher flux rate and savings in operating costs. In this regard, the computer simulation results can serve as a guide for selecting the membrane which will yield a predetermined lower effluent quality. (See also W88-00963) (Lantz-PTT)
W88-01022

STRATEGIES FOR HANDLING SOLUBLE WASTES GENERATED DURING MINCED FISH (SURIMI) PRODUCTION,
North Carolina State Univ., Raleigh. Dept. of Food Science.
D. Green, L. Tzou, A. C. Chao, and T. C. Lanier.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 565-572, 3 fig, 4 tab, 22 ref. Dept. of Commerce Grant No. NA83AA-D00012.

Descriptors: *Waste treatment, *Food-processing wastes, *Fish, *Wastewater treatment, Waste management, Surimi, Protein, Ultrafiltration, Water

quality, Rotating biological contractor, Biological treatment.

Preliminary findings of a two-year project on developing water and wastewater management strategies in surimi processing are prevented. The objective was to minimize wastewater generation by process modification at the primary source of pollution. The frozen surimi process, as it is practiced today, was first developed by the Japanese in the late 1950's. When the home market for traditional surimi-based products matured around 1974, the Japanese began to look abroad for indigenous Asian communities such as Japanese-American populations to whom they might sell their fish-based products. The potential growth for this emerging industry is such that Kibun, the leading manufacture of fish gel products in Japan, recently opened two U.S. based processing plants. Underlying thee development of these plants, are concerns over processing wastes generated in surimi production, particularly in light of the ever-more strict U.S. effluent guidelines. It was found that protein losses for menhaden surimi manufacture are similar to those reported for Alaska pollack operations. Ultrafiltration processing of wash water compares favorably to other established treatment processes and provides a potential means of recycling wash water. Bench-top studies demonstrated that counter-current washing resulted in approximately the same washing efficiency as conventional lateral flow processing using significantly less water in the process. Washing efficiency measurements were shown to be good indicators of product improvement (refinement). Future bench-top studies will be conducted to evaluate the efficiency of reusing ultrafiltration permeate in the wash process. Pilot scale studies will follow bench-top experiments to verify the findings. Additionally, studies will be conducted to assess the treatability of the permeate stream from ultrafiltration by rotating biological contractor (RBC) processing. (See also W88-00963) (Lantz-PTT)
W88-01023

USE OF COAGULANTS TO TREAT SEAFOOD PROCESSING WASTEWATERS,
Alaska Univ., Fairbanks. Dept. of Mechanical and Environmental Engineering.
R. A. Johnson, and S. M. Gallanger.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 573-583, 7 fig, 5 tab, 25 ref. Dept. of Commerce Grant No. NA81AA-D-00009.

Descriptors: *Wastewater treatment, *Coagulants, *Food-processing wastes, Food processing industry, Suspended solids, Hydrocarbons, Centrifugation, Coagulation, Chitosan, Ferric sulfate, Seafood, Alaska, Crabs, Salmon, Shrimp.

A Sea Grant-funded project was initiated in 1978 which studied suspended solids (TSS) removal from seafood processing wastewater streams. The initial phase of the project involved a series of laboratory and pilot plant tests using hydrocyclones as solids-liquid separation devices. A cyclone utilizes centrifugal forces to separate particulates with specific gravities greater than the carrier fluid. Results from this first phase indicated removal efficiencies of over 80% for shellfish processing wastewaters and 65% for salmon processing effluents. In all cases, the pilot plant effluent satisfied U.S. EPA standards on suspended solids. An initial economic analysis indicated the cyclone operating costs to be only a small fraction of the processing costs. Even though this past research has indicated cyclonic separation to be comparable to screens in suspended solids removal, there still remain fine particles in the overflow and considerable liquid in the cyclone underflow. Because of the obvious advantages of producing as a dry concentrate stream as possible, the main thrust of this research was to utilize coagulants to further concentrate the solids in the underflow. The initial phase of this research involved jar testing in a Fairbanks laboratory to ascertain appropriate coagulant dosages, pH, mixing time, and other parameters. Then, pilot plant testing was performed in Kodiak, Alaska, to confirm the feasibility of the proposed system. These studies showed that hydrocyclones followed by coagulant addition and dewatering can produce clarified stream low in particulates and concentrate TSS by a factor of around 100. Chitosan and ferric sulfate were found to be effective coagulants for crab, salmon, and shrimp processing wastewaters. Although the proposed system may not be presently economical for Alaskan processors, changes in the by-product market can alter this conclusion. (See also W88-00963) (Lantz-PTT)
W88-01024

HORIZONTAL-BAFFLED ANAEROBIC REACTOR FOR TREATING DILUTED SWINE WASTEWATER,
Hawaii Univ. at Manoa, Honolulu. Dept. of Agricultural Engineering.
P. Y. Yang, and C. Y. Chou.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 585-597, 10 fig, 6 tab, 18 ref. USDA HATCH 527 Project.

Descriptors: *Anaerobic digestion, *Farm wastes, *Swine, *Horizontal-baffled anaerobic reactor, *Wastewater treatment, Biological treatment, Chemical oxygen demand, Volatile solids, Solid retention time, Swine wastewater, Organic carbon, Methane, Sedimentation, Flocculation.

The horizontal-baffled anaerobic reactor was found to be effective in treating highly diluted swine wastewater (influent TCOD concentration < 5 g/L or TVS concentration < 2 g/L). The reactor provides an effective design in increasing the solid retention times (3-60 days) in spite of the lower hydraulic retention times (0.25-5 days) being operated. At 30 C, this anaerobic reactor provides a maximum of TCOD removal and maximum methane gas production rate of 81% and 0.8 L/L/day at a TCOD loading rate of 2.5 and 8.5 g/L/day, respectively. It is comparable with the anaerobic filter and aerobic-activated sludge processes in treating the supernatant of settled swine wastewater. Total COD loading rates for maximizing the organic removal, methane gas production rate, and methane yield at 30 C are different because the reactor is designed to combine both physical (sedimentation and/or flocculation) and biochemical effects. The reactor is considered as a potential anaerobic treatment alternative for a highly dilute swine wastewater because of its simplicity of both installation and operation. However, additional studies, such as long term operational effect (more than six months) of using a certain TCOD loading rate and quantitative shock loading effect on the performance of the reactor, should be further investigated. Thus, the economic evaluation can be followed. (See also W88-00963) (Lantz-PTT)
W88-01025

SIMPLIFIED KINETIC ANALYSIS OF THE ANAEROBIC FLUIDIZED BED REACTOR,
Manhattan Coll., Bronx, NY. Environmental Engineering and Science Program.
J. A. Mueller, K. Subburamu, and E. J. Donovan.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 599-611, 11 fig, 3 tab, 8 ref. EPA Contract No. 68-03-3074.

Descriptors: *Kinetic analysis, *Anaerobic digestion, *Wastewater treatment, *Fluidized bed reactors, Chemical analysis, Chemical oxygen demand, Michaelis analysis, Biological treatment, Sludge digestion, Mathematical analysis.

Simplified kinetic analysis provides a rational basis for understanding the anaerobic fluidized bed system. It is apparent that a fluidized bed reactor is a continual growth reactor, with a rapid accumulation of biological solids up to some limit. Attempting to obtain steady state effluent data at various COD loading rates when growth is well below the maximum provides no significant kinetic information since a relatively constant effluent concentration will result due to changes in biological growth. The technique of using a geometric increase in COD loading rate near the methane former maximum growth rate while maintaining an upper level on volatile acids concentrations will bring the reactor to a given design condition in the shortest possible time. The simplified Michaelis analysis of the fluidized bed data yields maximum methane former growth rates similar (within 25%) to suspended growth systems. However, the Michaelis constant is significantly greater than reported for suspended growth systems requiring relatively high volatile acid concentrations to maintain high reaction rates, e.g. 2500 mg/L for 80% of maximum rate. The three anaerobic systems utilized in this study (the anaerobic filter, the anaerobic upflow sludge blanket (contact) bed, and the anaerobic fluidized bed) provided relatively high unit removal rates compared to aerobic systems. The fluidized bed reactor maintained the highest biological solids concentration of the three systems allowing operation at significantly higher volumetric loading rates that are well above typical design values. (See also W88-00963) (Lantz-PTT)
W88-01026

UPGRADING BIOLOGICAL WASTEWATER TREATMENT USING AN EQUALIZATION/DENITRIFICATION SYSTEM,
CH2M/Hill, Denver, CO.
G. T. Diagger, N. N. Hatch, F. D. Bertz, and D. A. Skedsvold.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 613-625, 11 fig, 3 ref.

Descriptors: *Wastewater treatment, *Biological treatment, *Denitrification, *Process control, Nitrogen, Hydrogen ion concentration, Chemical treatment, Columbia Nitrogen Corporation.

An upgrade of the Columbia Nitrogen Corporation's (Augusta, GA) wastewater treatment system by the addition of an equalization/denitrification system is described. The equalization basin was sized to provide a significant reduction in both short-term (i.e., diurnal) and long-term (daily) variability. Using the transfer function approach and the equations for random variations in the influent concentration, a basin hydraulic retention time of 3 to 4 days was selected. The feasibility of incorporating denitrification in the design of the equalization basin was investigated using static batch denitrification tests. The results indicated that denitrification was feasible assuming that short-term equalization could be achieved to minimize variations in the pH. Such equalization was also expected to minimize potential acclimation lags and inhibitory or toxic responses by the denitrifying microorganisms. Control measures to minimize temperature losses and to control the concentration of denitrifying microorganisms were also considered necessary. Equalization/denitrification capabilities were added to the Columbia Nitrogen system by converting an 0.9 MG brush rotor oxidation ditch into a 4.0 MG equalization basin. Analysis of influent and effluent data indicated a significant reduction in the magnitude and variability of the TCOD loading of the waste stream. The reduction of TCOD loading was primarily a result of denitrification which was essentially complete about 90% of the time. The reduction in variability was in reasonably good agreement with the predictions of the transfer function models. The basin also resulted in a significant reduction in the variability of the pH, and denitrification increased the alkalinity of the wastewater. (See also W88-00963) (Lantz-PTT)
W88-01027

APPLICATION OF MEMBRANE ANAEROBIC REACTOR SYSTEM FOR THE TREATMENT OF INDUSTRIAL WASTEWATERS,
Dorr-Oliver, Inc., Stamford, CT.
A. Li, D. Kothari, and J. J. Corrado.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 627-636, 7 fig, 5 tab, 6 ref.

Descriptors: *Wastewater treatment, *Membrane Anaerobic Reactor System, *Industrial

wastewater, *Anaerobic digestion, Ultrafiltration, Suspended solids, Biomass, Chemical oxygen demand, Volatile solids, Methane.

The Membrane Anaerobic Reactor System (MARS) is a suspended growth anaerobic reactor followed by a membrane ultrafiltration unit for solid-liquid separation. The reactor contents are constantly being pumped to the membrane unit for solid-liquid separation; the permeate becomes the effluent, and the biomass is returned to the reactor. The MARS system is capable of achieving in excess of 95% COD removal at a volumetric loading rate of approximately 16 kg COD/cu m/day and up to 99% COD removal at a loading rate of 8 kg COD/cu m/day. Effluent suspended solids (SS) concentrations are consistently below 10 mg/L for all studies even with feed SS concentration up to 13,000 mg/L. The system can be operated to result in a net biomass yield between 0.06 to 0.12 kg VSS/kg COD removed. The observed methane production rate will vary from 0.28 to 0.34 cu m/kg COD removed at STP depending on the type of feed wastewater. Membrane flux correlates very well with the reactor VSS concentration for various wastewaters. High feed SS concentration seems to give lower flux across the membrane. (See also W88-00963) (Lantz-PTT)
W88-01028

BIOLOGICAL TREATABILITY DATA ANALYSIS OF INDUSTRIAL WASTEWATERS,
Oklahoma State Univ., Stillwater. School of Civil Engineering.
D. F. Kincannon, and E. L. Stover.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1935. p 627-643, 9 fig, 1 tab, 9 ref.

Descriptors: *Model studies, *Biological treatment, *Wastewater treatment, *Industrial wastewater, Activated sludge, Mathematical models, Rotating biological contactors, Organic load, Industrial wastes, Biological oxygen demand.

Modern approaches to design of activated sludge processes treating industrial wastewaters employ mathematical process models depicting the relationships among factors affecting the kinetics of wastewater purification. The aim of all design models is to provide more accurate predictive equations which are in keeping with the underlying metabolic and biological principles governing the purification process. Most models are developed by writing material balances describing the mass rate of change in substrate and in biomass. Describing mathematically these two functions is where the various design models differ. Each model contains biokinetic constants that are usually determined from biological treatability studies. The reliability of a design has been based upon accounting for the variability of the influent BOD, and flow rate. It has generally been assumed that the biokinetic constants are true constants. However, in previous papers, the authors have shown that this is not the case, and a procedure was developed for accounting for the variability of the biokinetic constants. During the early 1070's the authors introduced the concept of total organic loading for biological towers and rotating biological contactors. This concept has been developed into a design model for biological towers and rotating biological contactors. The results presented in this paper with three industrial wastes and also many other pilot plant studies conducted by the authors show that the total organic loading concept (food:microorganism ratio) provides an analysis that produces little scatter of the data; whereas, the relationship that is based upon the specific substrate utilization rate or specific growth rate is a function of the biological reactor substrate concentration shows extreme scatter in the data. Therefore, the model presented in this paper provides more accurate predictive equations for the purpose of biological treatability data analysis of industrial wastewaters. (See also W88-00963) (Lantz-PTT)
W88-01029

CONTROL OF SLUDGE BULKING IN A CARBOHYDRATE WASTEWATER USING A BIOSORPTION CONTACTOR,
Vanderbilt Univ., Nashville, TN. Dept. of Civil and Environmental Engineering.
T. H. Flippin, W. W. Eckenfelder, and M. C. Goronszy.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 645-650, 4 fig, 3 tab, 9 ref.

Descriptors: *Bulking sludge, *Carbohydrates, *Wastewater treatment, *Biosorption contactors, Sludge digestion, Settleable solids, Suspended solids, Aeration, Biological treatment.

A grain-milling facility has experienced problems with its wastewater treatment plant due to the presence of filamentous biological sludge. The addition of cationic polymer to the activated sludge prior to secondary settlement has generally been effective in meeting a discharge suspended solids (SS) pretreatment limit of 250 mg/L. The cost of polymer addition prompted a study to find a more cost-effective means of attaining a better settling sludge in order to meet effluent TSS pretreatment compliance conditions. The plant was suspected of suffering from filamentous bulking resulting from low organic loading conditions in the aeration basins. Studies reported here were conducted under actual plant operating conditions in order to provide a basis for a suitable methodology aimed at improving existing sludge settling characteristics. In applying the results of similar studies to bulking sludge control, it should be noted that filamentous growth caused by dissolved oxygen limitations and high organic loading will not respond to the high initial substrate loading induced biosorption process. All contactor systems examined exhibited significantly better sludge settling characteristics than the control system under normal operating conditions (Phase I). The system which offered the best settling sludge was the 30 minute contactor system followed by 2.5 days aeration time (2.5A); this system shared the same aeration time as the full scale plant. During the Phase II period of spills, the 90 minute contactor system (1.5A) offered a more stable effluent TSS than the control. A 90 minute anoxic contactor has been in full scale plant operation since October 1983. Effluent SS limitations have been met with only minimal polymer usage. It was anticipated that a more dramatic response in sludge settling characteristics would have been observed using an initial biosorption contactor. From a practical standpoint the contactor has provided a more cost effective wastewater treatment operation. From a theoretical standpoint further research is required by which to more clearly define the mechanisms that control biosorption and sludge settlement characteristics. This research and understanding is necessary if a predictive approach to solving sludge bulking problems is to be found. (See also W88-00963) (Lantz-PTT)
W88-01030

COMPARISON OF PARALLEL CLARIFIERS WITH LEVEL AND NONLEVEL WEIRS,
Weyerhaeuser Co., Tacoma, WA.
R. W. Sackellares, W. A. Barkley, and R. D. Simmons.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 651-664, 18 fig, 9 tab, 8 ref.

Descriptors: *Clarification, *Hydraulic profiles, *Wastewater treatment, *Weirs, Settleable solids, Sludge, Hydraulic geometry, Flow profiles, Temperature, Sedimentation.

Secondary clarifiers are designed to serve the dual function of clarifying the effluent and thickening the settled solids. Previous studies have shown that batch flux thickening theory adequately describes clarifier failure within pilot clarifiers. When the solids flux to the clarifier exceeded the sedimentation rate, the sludge blanket rose to the surface and massive amounts of solids were transported over the effluent weir. Recent recognition of the relationship between sludge blanket depth and effluent quality has lead to the design of deeper clarifiers. Classical design theory on the relationship between clarifier hydraulics and performance is incorrect. The mixed liquor influent can be visualized as being poured into the clarifier like molasses into water. The influent suspended solids (SS) slurry generates a density current which falls through the clarification zone into or onto the sludge blanket zone. This hydraulic movement results in: (1) channeling; (2) high upflow velocities at peripheral weirs; (3) recirculation within the clarifier; and (4) dead zones. Higher sludge blanket levels, which assist in decreasing channeling effects, are prone to deteriorate effluent quality during transient flow conditions. Residence time distribution and internal flow pattern analyses indicate that non-level weirs create a tortuous flow path which is effective in achieving clarification. The clarification performance of identical clarifiers (same dimensions and number of inlet ports) is equivalent under steady-state conditions regardless of the levelness of the effluent weirs. However, the nonlevel clarifier was susceptible to transient hydraulic upsets. Moderate temperature gradients (fractions of a degree) are the result of, rather than the cause of, non-ideal clarifier flow patterns. The Pflanz equation does not adequately model clarification performance. Sedimentation models based on plug flow and assumption of quiescent settling are inadequate. Operators of clarifiers, particularly ones with non-level weirs, should minimize step changes in sump and recycle flow rates. (See also W88-00963) (Lantz-PTT)
W88-01031

STUDY OF THE BIODEGRADABILITY OF 'RESIDUAL COD',
Delaware Univ., Newark. Dept. of Civil Engineering.
A. F. Gaudy, and T. R. Blachly.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 665-676, 9 fig, 1 tab, 15 ref. OWRT Project No. CT 370800.

Descriptors: *Biodegradation, *Chemical oxygen demand, *Waste treatment, *Wastewater treatment, Biological treatment, Aerobic treatment, Biomass.

Although biological treatment for removal of soluble waste organic substrates has proven to be a highly successful method, the efficiency of treatment is seldom, if ever, 100% by any of several methods for assessing influent and effluent concentrations of pollutants; i.e., COD, TOC, or BOD. It is common knowledge that when a readily metabolizable compound such as glucose is fed at a concentration of 1000 mg/L (1060 mg/L COD) to an acclimated microbial population under aerobic conditions in either a batch reactor or a continuous flow reactor, the lowest residual soluble COD usually attainable is between 30 and 50 mg/L. This residual is properly designated as non-biodegradable in practical engineering terms because it is residual with respect to the acclimated population. The major purpose of the current study was to examine the long-term fate of the COD remaining after aerobic treatment of a synthetic waste. Previously research involved the total retention of biomass, and it seemed to indicate that the simplest and most direct approach to the present study was to retain totally both the biomass and the residual COD and to monitor changes in each over time while feeding daily a given concentration of carbon source. Results revealed that the residual COD measured in batch or continuous flow treatability studies, while being the practical or engineering non-biodegradable residual with respect to secondary treatment processes, is not non-metabolizable over the long term. Over 90% of this 'near-term' residual is subject to biological metabolism. Allowing that long cell retention time corresponds to slow specific growth rate, the present work indicates that slow specific growth rates make for lower specific decay rates, but it would appear that an equilibrium value is approached. (See also W88-00963) (Lantz-PTT)
W88-01032

INFLUENCE OF CONTINUOUS VERSUS CHANNELS ON MIXING CHARACTERISTICS AND PERFORMANCE OF ANAEROBIC

DOWNFLOW STATIONARY FIXED FILM (DSFF) REACTORS BEFORE AND DURING WASTE TREATMENT,
National Research Council of Canada, Ottawa (Ontario). Div. of Biological Sciences.
R. Samson, L. Van den Berg, and K. J. Kennedy.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 677-685, 8 fig, 2 tab, 14 ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Waste treatment, *Hydraulic profiles, *Channels, Anaerobic downflow stationary fixed film reactors, Biological treatment, Mixings, Hydraulic geometry, Chemical oxygen demand, Volatile acids, Methane, Bacteria.

Studies were performed to improve the performance of the downflow stationary fixed film (DSFF) reactors by changing the configuration of the vertical channels inside the reactor to reduce the volume unavailable for the biochemical reactions. Differences in performance were analyzed with respect to the mixing profiles through the reactors. Mixing characteristics of DSFF reactors were shown to be a function of their geometrical configurations (horizontal channel separation and feed distributor) and their operation with and without recirculation. Recycling at a ratio 4:1 improved the mixing in the reactor having continuous channels; however, with non-continuous channel reactor shortcircuiting became noticeable. Performance during start-up was characterized by a high degree of COD reduction (up to 95%), an increase in methane production rate (up to 3.5 cu m/cu m/day), and a volatile acid concentration below 1,000 mg/L. Horizontal spacing (e.g., non-continuous channel reactor) improved reactor performance by improved mixing. The growth of bacteria in the poorly mixed reactor produced more dead space and shortcircuiting than in the better mixed reactor. The result was a poorer support utilization in a poorer mixed reactor. (See also W88-00963) (Lantz-PTT)
W88-01033

FULL SCALE ANAEROBIC TREATMENT OF A PULP AND PAPER INDUSTRY WASTEWATER,
A.C. Biotechnics, Inc., Woodbury, NY.
B. Frostell, W. Bonkoski, and J. E. Sointio.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 687-696, 10 fig, 4 tab, 15 ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Pulp and paper industry, *Industrial wastewater, Biological treatment, Chemical oxygen demand, Sludge, Methane, Sulfur, Biological oxygen demand.

A full scale ANAMET anaerobic contact reactor system was constructed at the Hylte Bruks AB newsprint mill in Sweden. The plant is treating preclarified wastewater from TMP-production, groundwood-, magnefite- and deinked pulp together with evaporator condensate and aerobic excess sludge. The design capacity of the plant is 29.6 metric tons of COD (11.3 metric tons of BOD) per day in a flow of 6100 cu m. The plant is operated at 35-38 C. Results from the first five months of operation were given. Full flow was reached after 13 weeks of operation. The wastewater has been considerably more diluted than anticipated resulting in an organic load of 18-20 metric tons of COD/day at full flow. The BOD concentration has been around 1.0 kg/cu m. Start-up has required a longer time than anticipated, largely due to problems with sulfide inhibition. After 5 months of operation, a COD reduction of 60% and a BOD reduction of 70% were obtained. Specific gas production is 0.14-0.15 cu m CH4/kg COD added. Major conclusions from the existing experience in this plant are: (1) Anaerobic treatment of this pulp and paper industry effluent combined with gas recovery is technically feasible on a full scale basis. Advantages anticipated from smaller scale experiments have been largely fulfilled; (2) A 65-70% BOD reduction has been achieved despite influent concentration is only around 1 kg BOD/cu m; (3) The start-up has required considerable time. Conversion to gas is improving still after 5 months of operation; and (4) During the start-up, a soluble sulfide level in excess of 0.10 kg S/cu m has resulted in stability problems at pH 7. (See also W88-00963) (Lantz-PTT)
W88-01034

ANAEROBIC TREATMENT OF A VARIETY OF INDUSTRIAL WASTE STREAMS,
Duncan, Lagnese and Associates, Inc., Pittsburgh, PA.
M. Olthof, W. R. Kelly, G. Wagner, and J. Oleszkiewicz.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 697-704, 1 fig, 7 tab, 1 ref.

Descriptors: *Anaerobic digestion, *Industrial wastes, *Wastewater treatment, Chemical analysis, Salts, Sulfates, Organic compounds, Toxicity, Chemical wastes, Cultures.

Treatability studies were conducted on some waste streams. Each of the waste streams was unique and required special attention during the acclimation phase of the testing. It is important to find the right bacteria for seed material and to develop an acclimated culture in the reactors. In addition to the special nature of a lot of organics present in the chemical industry waste, there are a few other factors that often impact the success of biological treatment on these waste streams. Some of these are: (1) salt content; (2) sulfate content; (3) nondegradable organics; and (4) toxic or inhibitory compounds. (See also W88-00963) (Lantz-PTT)
W88-01035

DYNAMIC PERFORMANCE OF AN ANAEROBIC REACTOR COMBINING AN UPFLOW SLUDGE BLANKET AND A FILTER FOR THE TREATMENT OF SUGAR WASTE,
National Research Council of Canada, Ottawa (Ontario). Div. of Biological Sciences.
S. R. Guiot, and L. Van den Berg.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 705-717, 9 fig, 5 tab, 26 ref.

Descriptors: *Anaerobic digestion, *Upflow sludge blanket, *Filtration, *Wastewater treatment, *Waste treatment, *Sugars, Biomass, Sludge digestion, Anaerobic reactors, Chemical oxygen demand, Biological treatment, Kinetics.

The loading capacity of any biological wastewater treatment system is essentially dictated by the amount of active biomass retained in the reactor providing a sufficient contact between active biomass and organic waste is assured. The more sludge that can be retained, the higher the loads that can be applied. Retention of more active biomass was the objective for developing of the hybrid Upflow Sludge Blanket Filter (UBF) reactor. The Upflow Anaerobic Sludge Blanket (USAB) reactor is limited by the settling properties of the granular sludge. The Anaerobic Filter (AF) reactor is limited by plugging and channelling due to the accumulation of suspended biomass in the bottom of the reactor. By combining an upflow granular sludge blanket and an anaerobic filter made of plastic rings floating in the top third of the reactor, the UBF hybrid reactor minimizes the disadvantages of both USAB and AF reactors. A lab-scale UBF reactor was found to be able to treat medium strength soluble sucrose waste (up to 1% sucrose waste) at up to 22 g COD/L/d loading rate with a 95% soluble COD removal efficiency. Maximum observed methane productivity was 8 vol/vol/d. The filter was efficient in retaining biomass. Biomass content of the effluent relative to the reactor biomass concentration was very low. In addition, the UBF reactor was a simple design and required no special gas or sludge separation device. The biomass underwent changes in its microbial composition with increasing loading rate and increasing influent concentration, resulting in a decrease in the relative proportion of the acetoclastic biomass. This reduces in practice the capacity of the system. Kinetic considerations showed that the value of the decay coefficient was not negligible. Also, these values were affected by substrate concentration. (See also W88-00963) (Lantz-PTT)
W88-01036

GRANULAR ACTIVATED CARBON REMOVAL OF PRIORITY POLLUTANTS IN A COMBINED MUNICIPAL/INDUSTRIAL WASTEWATER,
A. M. C. McManus, P. H. Werthman, and J. R. Westendorf.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 719-734, 19 fig, 3 tab, 7 ref.

Descriptors: *Granular activated carbon, *Municipal wastewater, *Industrial wastewater, *Priority pollutants, *Wastewater treatment, Organic compounds, Adsorption, Economic aspects, Monitoring, Chemical oxygen demand, Organic carbon.

Granular activated carbon is an effective treatment method for the removal of organic priority pollutants but requires extensive pilot testing to develop design information for a specific wastewater matrix. Competitive adsorption by components in the background matrix dramatically effects carbon removal performance for individual solutes in this case decreasing individual solute removal capacities by as much as 80-97%. Therefore, determining the economics of carbon adsorption for a specific wastewater matrix is difficult unless a sufficient data base is available to characterize treatment efficiency. Competitive adsorption also increases treatment costs in that it requires facilities with limits for specific priority pollutants to determine the earliest eluting pollutant and then monitor for that pollutant often with expensive sophisticated equipment to determine pollutant breakthrough. Monitoring for a generalized pollutant parameter, such as COD or TOC, will not provide sufficient information regarding breakthrough of specific solutes. This study also indicates that desorption is a significant factor in terms of compliance with effluent limitations and could cause permit violations well before the actual breakthrough of the compounds of concern. (See also W88-00963) (Lantz-PTT)
W88-01037

TREATMENT OF HIGH STRENGTH WASTEWATER CONTAINING ORGANIC SOLVENTS,
Woodard and Curran, Gorham, ME.
K. R. Marston, and F. E. Woodard.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 735-739, 2 fig, 5 tab.

Descriptors: *Water quality control, *Wastewater treatment, *Organic compounds, *Solvents, *Design standards, *Boston, Massachusetts, Millipore Corporation, Industrial wastewater, Activated sludge.

The Millipore Corporation manufactures and markets precision separations systems for the pharmaceutical, microelectronics, health care and other industries. Some of the membranes used in their products are manufactured at Millipore's Bedford, MA facility. The manufacturing activities result in the production of over 100,000 gal/d of wastewater containing traces of glycerin, alcohol, acetone and other organic chemicals. The wastewater is discharged to the municipal sewer which is connected to the Metropolitan District Commission (MDC) sewer system serving the Metropolitan Boston area. Shortly after the implementation of their Industrial Pretreatment Regulations, the MDC notified the Millipore Corporation of their intention to place limitations on the discharge of solvents from the Bedford plant. Based upon a number of factors, including removal efficiency, implementation time, flexibility and cost, a program of segregation of high strength waste streams for pretreatment using the activated sludge

process was implemented at the Millipore Corporation. This paper discusses the design and operation of this activated sludge system at Millipore's Bedford plant. (See also W88-00963) (Lantz-PTT)
W88-01038

UPGRADING OF WASTEWATER FACILITIES BY PRIMARY EFFLUENT FILTRATION,
Zimpro, Inc., Rothschild, WI.
G. A. Garzonetti.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 741-746, 6 fig, 3 tab, 3 ref.

Descriptors: *Wastewater facilities, *Filtration, *Wastewater treatment, *Primary effluent filtration, Primary treatment, Pulsed bed wastewater filter, Filtration, Suspended solids, Biochemical oxygen demand, Clarification.

A pulsed bed wastewater filter is shown to effectively remove suspended solids and biochemical oxygen demanding material from the overflow from a primary clarifier. The technique promises to reduce the costs and energy usage associated with conventional sewage treatment processes. Extensive research at the University of California Davis shows the technique (known as Primary Effluent Filtration, or PEF) can eliminate 65-70% of the suspended solids and 50-60% of the BOD from primary effluent. Energy requirements for similar removals by activated sludge are estimated to be 10 times as great. Among PEF applications are advanced primary treatment prior to aquatic discharge or land treatment; secondary treatment with two-stage filtration, or PEF in advance of fixed growth systems, such as trickling filters; or expansion or upgrading of secondary treatment. (See also W88-00963) (Lantz-PTT)
W88-01039

TREATMENT OF TAR SAND PROCESS WATERS BY MEANS OF TWO-STAGE, POLYMER-AIDED, AIR FLOTATION,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
M. H. Bushway, G. D. Boardman, and W. F. McTernan.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 747-756, 4 fig, 4 tab, 6 ref.

Descriptors: *Wastewater treatment, *Tar sands, *Process waters, *Polymers, *Air flotation, Industrial wastewater, Flotation, Bitumen, Suspended solids, Organic matter, Organic carbon, Dissolved solids, Chemical oxygen demand.

The term sand refers to consolidated or unconsolidated rock with interstices that contain viscous or solid bitumen which, in its natural state, cannot be recovered by methods commonly used in the petroleum industry. To extract bitumen from tar sand, it is necessary to first convert the material into a form which can be transported to production wells. Among the more promising extraction techniques now recognized are in situ combustion and steam purge methods. The Department of Energy Office at Laramie and Wyoming Research Corporation (formerly united as the Laramie Energy Technology Center or LETC) have been studying the two types of recovery methods for several years. The wastewater used in this study was generated in an in situ steam purge experiment conducted by LETC in 1980. In this experiment 1,150 barrels of bitumen and 6.250 barrels of wastewater (referred to as TS-1SX process waters) were produced. The TS-1S waters contained high levels of solids and organic matter so some form of treatment would be required before the waters could be recycled or disposed of in an acceptable manner. The work described in this paper was undertaken to investigate the potential of using a two-stage, air flotation system to treat the TS-1S waters. Earlier studies conducted in laboratories revealed that air flotation was a viable process, but the configuration and/or operation of the systems considered previously were/was somewhat different. System performance was evaluated on the basis of changes in TOC, TSS, total solids, TDS, and COD. Good removals of SS and TOC were achieved at all combinations of the independent variables considered when the system was operated at 25 C. Residual levels of SS and TOC in second stage effluents averaged 9 and 53 mg/L, respectively. (See also W88-00963) (Lantz-PTT)
W88-01040

STUDIES ON THE AMMONIUM REMOVAL AND FILTRATION PERFORMANCE AND REGENERATION OF CLINOPTILOLITE,
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
S. R. Linne, and M. J. Semmens.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 757-770, 16 fig, 2 tab, 14 ref.

Descriptors: *Wastewater treatment, *Ion exchange, *Ammonium, *Filtration, *Clinoptilolite, *Zeolites, Performance evaluation, Costs, Pretreatment of wastewater, Regeneration, Leakage, Sodium chloride, Hydrogen ion concentration, Calcium.

The need for ammonia removal from municipal and industrial wastewater has been realized for many years. There are several processes that have been studied and used for ammonium removal, one of which is ion exchange by clinoptilolite. Clinoptilolite is a natural zeolite which has a favorable selectivity and capacity for ammonium. Ammonium removal by clinoptilolite has been used in full scale operations but, due to the costs associated with the process, its use has been limited. The high cost of the process can be attributed to two areas: regeneration and influent water pretreatment. To improve the cost effectiveness of the process, three areas which need improvement are studied: the water pretreatment requirement, the regeneration conditions, and the use of clinoptilolites other than Hector clinoptilolite (the most widely studied and used clinoptilolite). Regeneration was effectively accomplished with 3% NaCl. Higher salt concentrations improved performance very little and would not be recommended in practice. With a regeneration time of 200 minutes, no effect of pH was evident on the subsequent service run. Calcium concentrations < 100 mg/L in the regenerant did not appear to adversely affect ammonium removal performance, but higher concentrations caused a deterioration in subsequent performance. Direct application of wastewater to clinoptilolite beds is feasible and research should be continued to optimize the system. A difference in ammonium removal performance was noted after 8-10 hours of operation in almost every run. After six service periods, no permanent loss in capacity was noted. The regeneration scheme, 3% NaCl, 2-3 BV/hr for 7 hours, appeared to adequately regenerate both systems. The best ammonium removal performance was found at the lowest loading rate (5 BV/hr). (See also W88-00963) (Lantz-PTT)
W88-01041

RELIABILITY AND REPRODUCIBILITY OF SMALL-SCALE BIOLOGICAL TREATMENT STUDY RESULTS,
Lawler, Matusky and Skelly Engineers, Pearl River, NY.
T.-S. Hsu, P. J. Lawler, and A. W. Edwards.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 771-782, 4 fig, 7 tab, 3 ref.

Descriptors: *Wastewater treatment, *Biological treatment, *Glen Falls, *New York, Ciba-Geigy Corporation, Industrial wastewater, Pilot studies, Organic loading, Kinetics, Nitrification, Oxygen, Solids.

The City of Glens Falls, New York, is in the process of constructing a secondary wastewater treatment facility to upgrade its existing primary treatment plant. The new plant, described in the Wastewater Facilities Plan Amendment of June 1981 prepared by Lawler, Matusky and Skelly Engineers (LMS), was originally designed to serve the population and industries of Glens Falls and to treat the pretreated industrial wastewater from the Ciba-Geigy Corporation (Ciba-Geigy) pigments facility. A pilot evaluation program was initiated and conducted by Ciba-Geigy and its consultant, the AWARE Corporation (AWARE), in January 1981 to determine the compatability of the Ciba-Geigy wastewater with joint secondary biological treatment and to develop process design criteria for the design of the treatment facility. Subsequently, LMS prepared a new Facilities Plan Amendment (completed in July 1982) and additional pilot evaluations in June 1982. This paper describes and summarizes the results obtained from the two studies on the same combination of Glens Falls/Ciba-Geigy wastewater. Side-by-side comparisons of pertinent process parameters, including organic loading (F/M), substrate removal kinetics, nitrification, oxygen utilization, solids production, solids-liquid separation, and nutrient requirements, are presented. The paper shows that the two studies, at markedly different scales of reactor size and flow rate, produced very similar results in terms of reaction parameters. It is hoped that this comparison will shed some light on the effect of equipment size on laboratory and pilot biological treatability studies. (See also W88-00963) (Lantz-PTT)
W88-01042

STATE OF THE ART OF ANAEROBIC DIGESTION FOR INDUSTRIAL APPLICATIONS IN THE UNITED KINGDOM,
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
G. K. Anderson, and C. B. Saw.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 783-793, 6 fig, 3 tab, 44 ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Industrial wastewater, *United Kingdom, Anaerobic reactors, Nutrients, Filtration.

The different methods of anaerobic treatment: 1. conventional anaerobic digester, 2. completely mixed anaerobic contact digester, 3. anaerobic packed bed reactor (APBR)/anaerobic filter, 4. upflow anaerobic sludge blanket (UASB) reactor, 5. anaerobic fluidized bed, and 6. two-phase anaerobic digestion) in general use in industry are outlined in this paper. A discussion is presented of difficulties encountered in biomass retention in various types of reactor, and a review is given of the current state-of-the-art. The development of a completely new concept for operating completely mixed digesters for treating industrial wastewaters is proposed. With optimized reactor design, it is hoped that this newly developed 1-stage system using membrane filtration within the anaerobic reactor will eventually solve the problem of retaining a sufficient quantity of active biomass in the reactor. Work is also being carried out to apply this technique of biomass separation in a two-phase anaerobic digestion system. The paper also describes the research being carried out into the causes of poor solid/liquid separation and the solutions to the problems. It was found that nutrient deficiencies will cause filamentous growth, resulting in poor sedimentation and filterability. Filamentous growth can be prevented by maintaining a N/P ratio of about 5. Despite the many advantages of the anaerobic digestion process in the waste treatment field, in particular high strength wastewater, it has not yet reached its full potential. There is a lot of mileage left in anaerobic digestion, especially with the introduction of the potentially superior 'second generation' reactors. The industrial uses of anaerobic digestion technology is growing rapidly on a world-wide basis, and the United Kingdom is well-placed in the technology stakes. (See also W88-00963) (Lantz-PTT)
W88-01043

REMOVAL OF POLYNUCLEAR AROMATIC HYDROCARBONS FROM PRIMARY ALUMINUM AIR POLLUTION CONTROL SCRUBBER WASTEWATER,
Rexnord, Inc., Milwaukee, WI.
R. A. Osantowski, C. R. Dempsey, and K. A.

Dostal.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 795-802, 2 fig, 5 tab, 5 ref.

Descriptors: *Polynuclear aromatic hydrocarbons, *Aluminum, *Air pollution, *Wastewater treatment, Scrubbers, Industrial wastewater, Pilot studies, Benzo-a-pyrene, Activated carbon.

The electrolytic reduction of alumina produces large volumes of gaseous products which must be cleaned before release. In addition, the manufacture of prebaked anodes creates contaminated air streams which must be cleaned. Wet scrubbing is frequently used to control these air streams and represents a major source of wastewater from this industry. This wastewater is known to contain polynuclear aromatic hydrocarbons (PAH's), some of which have been tentatively classified as known or suspected, human or mammalian carcinogens. In March 1983, the EPA proposed effluent standards which, among other things, limited the release of PAH's from the primary aluminum subcategory based on the transfer of precipitation and activated carbon technology from other industrial categories. The control of PAH's was based on an achievable concentration of 10 micrograms/L of benzo(a)pyrene as an indicator for the removal all PAH's to 10 micrograms/L. From May to September 1983 a series of bench- and pilot-scale studies were conducted with primary aluminum plant wastewaters to help evaluate the ability of these technologies to remove benzo(a)pyrene and other PAH's from actual primary aluminum scrubber wastewater. Specific objectives included determining the need for granular activated carbon to remove the PAH's to 10 micrograms/L and evaluating the use of benzo(a)pyrene as an indicator for the removal of all PAH's. (See also W88-00963) (Lantz-PTT)
W88-01044

REPLACEMENT FOR THE SILT DENSITY INDEX; PERMANGANATE DEMAND TO PREDICT REVERSE OSMOSIS MEMBRANE FOULING,
Air Force Clinic, McChord AFB, WA.
R. D. Binovi, and R. N. Kinman.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 803-809, 1 fig, 7 tab, 11 ref.

Descriptors: *Wastewater treatment, *Silt density index, *Permanganates, *Reverse osmosis, *Membrane processes, *Membrane fouling, Fouling, Permanganate Demand Test, Humic acids.

Reverse osmosis is a pressure driven separation process which has found widespread acceptance in desalination, water reclamation, and the production of water of exceptional quality. Designers are attracted to the simplicity of design, low energy requirements, and the potential for high recovery that it offers. Perhaps the most challenging of the problems associated with the use of reverse osmosis technology is fouling. Fouling is the reduction of permeate flux with time caused by constituents in the feed or changes in the membrane structure. It introduces a degree of uncertainty to a planner as to the usable life of the membrane and the need for pretreatment of the feedwater. Unfortunately, the relationship between fouling and the normal characterizations of the feedwater, i.e., hardness, turbidity, suspended or dissolved solids has never been quantified or hardly explored. Currently, the results of a simple filtration test, the Silt Density Index (SDI), have been used to determine if the process can be reasonably operated for an extended period of time without fouling. The SDI cannot predict the expected lifespan of the membrane nor can it react linearly with the concentration of the potential fouling agents. However, it was found here that the Permanganate Demand Test can accurately predict the rate by which a spiral would reverse osmosis membrane fouled. The test responded linearly to varying concentrations of humic acid. The rate by which the permeate flux declined could be related to the permanganate demand of the feedwater. The permanganate demand test can be performed with simple apparatus to predict the useful membrane life of the need for feedwater pretreatment. The predictive equation developed allows the operator to calculate when the membrane will fail to process the desired amount of water. (See also W88-00963) (Lantz-PTT)
W88-01045

MECHANISM OF AMMONIA REMOVAL IN A SINGLE-STAGE NITRIFICATION SYSTEM HAVING A LONG HRT,
Merck Sharp and Dohme Research Labs., Rahway, NJ.
S.-E. Lee, and H. Naimie.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 811-820, 4 fig, 7 tab, 9 ref.

Descriptors: *Air stripping, *Ammonia, *Wastewater treatment, *Nitrification, *Hydraulic retention time, Hydrogen ion concentration, Temperature, Mixed liquor solids, Suspended solids, Biological oxygen demand, Kjeldahl nitrogen, Nitrogen.

Removal of ammonia by air stripping in a single stage nitrification system was found to be significant under the operating conditions employed during this study, e.g., a long hydraulic retention time (HRT) (>3.5 days), high temperature (39 C), and high influent pH (> 9.5). More ammonia was stripped off at higher air flow rates. Although there was some trend toward higher ammonia removal by stripping at higher mixed liquor suspended solids (MLSS) concentrations, the effect of MLSS concentration on the degree of ammonia stripping needs to be studied further. A direct correlation was found to exist between percent ammonia removal and HRT. Even if the amount of ammonia stripped off was included, the nitrogen balance around the experimental units still did not close. However, since during treatment of an industrial wastewater with high BOD, significant amounts of total Kjeldahl nitrogen (TKN) could be used for cell synthesis. This mechanism should be also considered for the complete nitrogen balance. When nitrification alone was considered as the sole mechanism for ammonia removal, a more open nitrogen balance resulted at a longer HRT. For the application of the single nitrification system to the treatment of industrial wastewaters, a well designed pilot plant study including off gas and sludge analysis should be conducted to determine the necessary design parameters such as HRT, SRT, air and alkalinity requirements. (See also W88-00963) (Lantz-PTT)
W88-01046

CASE STUDY FOR THE TREATMENT OF AN EXPLOSIVES WASTEWATER FROM AN ARMY AMMUNITIONS PLANT,
AWARE, Inc., Nashville, TN.
S. E. Shelby, P. W. Lankford, and R. W. McCollum.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 821-836, 11 fig, 8 tab.

Descriptors: *Wastewater treatment, *Explosives, *Ammunition plants, *Industrial wastewater, *Nitrates, Heavy metals, Organic compounds, Case studies, Nitrates, Costs, Economic aspects.

Contaminated wastewaters are generated from the production, handling and loading of explosive materials in Army Ammunition Plants (AAP). Characteristically, these small volume wastewaters are often contaminated with live explosive materials and other explosive constituents such as heavy metals, organics, and nitrates. Historically the treatment approach for these wastes has been focused on decomposing or desensitizing the explosives compounds; however, due to the small waste volumes, little additional treatment for other parameters has been provided. Recently, advanced technologies, such as ultraviolet light catalyzed chemical oxidation processes, have been studied for treatment of explosives plant wastewaters. The selection of a treatment process for explosives wastewaters or other wastewaters containing numerous complex organic compounds becomes an evaluation of an expensive advanced system versus a less expensive conventional system. The superior performance of the advanced system is normally offset by greater operating and maintenance complexity and higher cost. (See also W88-00963) (Lantz-PTT)
W88-01047

TREATMENT OF AN RDX-TNT WASTE FROM A MUNITIONS FACTORY,
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
M. J. Semmens, D. Barnes, and M. O'Hara.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 837-842, 1 fig, 3 tab, 8 ref.

Descriptors: *Wastewater treatment, *Explosives, *Trinitrotoluene, *Cyclonite, *Ammunition, *Industrial wastewater, Calcium hypochlorite, Hydrogen ion concentration, Temperature, Alkali.

A munitions handling facility in New South Wales, Australia was routinely discharging high concentrations on trinitrotoluene (TNT) and cyclonite (RDX) in their plant effluent. The TNT and RDX concentrations in bomb boil out water can be effectively reduced by treatment with hot caustic dose and calcium hypochlorite. Sodium hydroxide should be added to the water to raise the pH to 10-10.5 and calcium hypochlorite added at 1.2 g/L. To allow for variations in water quality and contaminant concentration (mainly due to solids carry over), the dosing system should be capable for raising the pH to 11 and dosing calcium hypochlorite at rates between 0.5 and 2.0 g/L. The ratio of calcium hypochlorite to TNT appears to be approximately 10:1 to achieve TNT decomposition at these pH values. The temperature of the reaction tank contents should be raised to approximately 100 C and maintained for 10-15 minutes. The reaction can be monitored by measurement of pH and visual color observation. If the pH of the solution is greater than 8 at the end of the high temperature reaction, it can be assumed that the RDX has been decomposed, and if there is no red coloration, it can be assumed that the TNT has decomposed. Additional alkali or hypochlorite can be added if the reactions are judged to be incomplete. Effluents from the reaction tank can be assumed to contain low concentrations of TNT and RDX, will have pH values of 8-9 but are likely to contain residual chlorine and be relatively hot. Provisions must, therefore, be made to cool the waste prior to discharge. Additional studies are needed to identify the byproducts of chlorination and to determine the kinetics of TNT and RDX breakdown at temperatures below 100 C. (See also W88-00963) (Lantz-PTT)
W88-01048

INVESTIGATION OF FLUORIDE REMOVAL FROM SEMICONDUCTOR WASTEWATER USING WATER SOFTENING SLUDGE,
Millipore Corp., Bedford, MA.
J. L. McDonough, and J. C. O'Shaughnessy.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 843-851, 8 fig, 3 tab, 17 ref.

Descriptors: *Fluorides, *Semiconductors, *Wastewater treatment, *Water softening, *Sludge, *Waste disposal, Sludge disposal, Calcium, Hydrogen ion concentration, Lime, Chemical precipitation.

This investigation shows that the codisposal of water softening sludge by use in the treatment of acidic fluoride wastewater is both feasible and effective. To deliver adequate calcium in the treatment of fluoride wastewater, the use of thickened water softening sludge is recommended. Thickened softening sludge also provides sufficient chemical solids at a pumpable consistency without unnecessary water. In addition the thickened

sludge provides a greater degree of acid neutralizing capacity. The use of water softening sludge in the treatment of the wastewater did not result in excessively high effluent pH levels which would require reacidification prior to discharge. Conversely, treatment of the wastewater with lime did not result in high final pH levels due in part to the wastewater's lack of buffering capacity. High pH levels were not required to achieve significant fluoride reductions. On an equivalent basis, lime was only slightly more effective in the removal of fluoride than the thickened softening sludge. The precipitated material formed using the water softening sludge settled better than the precipitated material formed using lime. It appears that the particle size and wetted nature of the water softening sludge is better suited for dissociation to calcium ion than limestone or pulverized calcium carbonate. (See also W88-00963) (Lantz-PTT)
W88-01049

SELECTION OF STATISTICALLY APPROPRIATE COMPLIANCE SAMPLING INTERVALS,
Environmental Resources Management-North Central, Inc., Palatine, IL.
For primary bibliographic entry see Field 5G.
W88-01050

TWENTY YEARS OF RESPIROMETRY,
Arthur Technology, Inc., Fond du Lac, WI.
For primary bibliographic entry see Field 5G.
W88-01051

GEOTHERMAL WASTEWATER TREATMENT AND DISPOSAL,
Collins and Ryder Consulting Engineers, Larkspur, CA.
For primary bibliographic entry see Field 5G.
W88-01052

EVALUATION OF FACTORS AFFECTING THE OXYGEN TRANSFER FROM HIGH-SPEED FLOATING SURFACE AERATORS,
Eastman Kodak Co., Rochester, NY.
R. A. Poduska, and R. F. Hager.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 893-900, 4 fig, 4 tab, 10 ref.

Descriptors: *Hydraulic equipment, *Wastewater facilities, *Wastewater treatment, *Aerators, *Oxygen transfer, Flotation, Dissolved oxygen, Impellers, Aeration.

In response to a sudden and prolonged deficit imbalance in dissolved oxygen (DO) in an activated sludge system using only high-speed floating surface aeration, a study was conducted to evaluate the primary factor causing this condition. It was found that the DO deficit was primarily due to reduced oxygen transfer efficiencies of the aerators as a result of damage to the impellers within the treatment system. In-situ oxygen uptake evaluations yielded an overall oxygen transfer efficiency of 1.45 lb O2/hp/hr. This value is substantially lower than field values reported in the literature for similar aeration equipment. As a result of a horsepower survey, it was shown that nearly 40% of the 109 aerators were operating at < 73 hp and 14% were operating at < 65hp. All the aerators are rated for 75 hp. An individual aerator was selected so that its oxygen transfer efficiency could be measured in a test tank in an as-is condition. Mechanical inspection showed that impeller to be out of specification along with vibrations on the bearings and stress cracks on the working parts. By replacing the damaged impeller, a 25.6% increase in N0 resulted with only a 7.6% increase in horsepower. The oxygen transfer efficiency for these types of floating surface aerators are apparently quite sensitive to the horsepower used. No relationship between aerator horsepower and N0 was possible in this study. Therefore, aerators that require maintenance can be identified by simply measuring the horsepower used. Significant cost savings can be obtained by periodically surveying individual aerator horsepower and performing maintenance on the basis of low values. (See also W88-00963) (Lantz-PTT)
W88-01053

CASE HISTORY - MINIMIZATION OF ONCE-THROUGH COOLING WATER USE AND DISCHARGE FROM BATCH FERMENTOR COOLING,
Upjohn Co., Kalamazoo, MI.
For primary bibliographic entry see Field 3E.
W88-01054

APPLICATION OF NEW TECHNOLOGIES TO LIVESTOCK WASTE MANAGEMENT,
National Fertilizer Development Center, Muscle Shoals, AL.
J. B. Martin, B. G. Ruffin, J. O. Donald, and L. L. Behrends.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 218-220, 4 tab, 10 ref.

Descriptors: *Waste management, *Livestock, *Poultry, *Waste disposal, *Waste treatment, Domestic animals, Agricultural wastes, Energy, Cattle, Swine, Aquaculture, Waste recovery.

Recycling livestock and poultry waste through biological refeeding systems or through energy recovery systems may provide an economic incentive for farmers to consider alternative waste management systems. Several refeeding/energy recovery systems including the use of poultry house waste (broiler litter) in several beef cattle production systems, and recycling swine wastes through an aquaculture production (algae-fish-water chestnut-biogas) system, are discussed. (See also W88-01083) (Lantz-PTT)
W88-01122

ACID MINE DRAINAGE: SURFACE MINE TREATMENT AND IN-SITU ABATEMENT TECHNOLOGY,
South Carolina Univ., Columbia. Dept. of Geology.
For primary bibliographic entry see Field 5G.
W88-01142

TECHNIQUES FOR INDUSTRIAL POLLUTION PREVENTION: A COMPENDIUM FOR HAZARDOUS AND NONHAZARDOUS WASTE MINIMIZATION,
North Carolina State Univ., Raleigh. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5G.
W88-01197

DETOXICATION OF HAZARDOUS WASTE.
Ann Arbor Science, Ann Arbor, MI. 1982. 362 p. Edited by Jurgen H. Exner.

Descriptors: *Waste treatment, *Detoxification, *Hazardous wastes, *Wastewater treatment, Incineration, Waste management, Polychlorinated biphenyls, Case studies, Dioxins, Biological treatment.

A symposium by the Division of Environmental Chemistry of the American Chemical Society, focuses on the detoxification of hazardous waste as an alternative and/or a complement to storage and destruction techniques. The book contains four sections: (1) incineration and waste management; (2) treatment, recovery and destruction of polychlorinated biphenyls (PCB); (3) a case study of the destruction of dioxins; and (4) the biological detoxification potential of genetic engineering, microbial and enzymatic techniques. Section 1 describes the design and operation of multipurpose industrial incinerators for regional waste treatment centers. The question of destruction of hazardous components of the incinerator is discussed, and the ranking of hazardous compounds for incinerability is debated in several fundamental chapters. Section 2, on PCB detoxification, illustrates the diversity of possible approaches to treating a specific type of waste and serves as a model for detoxification of other pollutants. Land- and ocean-based, molten salt, diesel, and cement kiln incineration have been tested. Plasma arc and other high-temperature processes have been explored. The treatment of PCB-contaminated transformer fluids illustrates the role of detoxification in recovery and reuse of valuable chemicals. PCB destruction by organometals, ultraviolet light, alkali metal alkoxides and chemical reduction are feasible and have been tested by numerous investigators. The final section focuses on the future by examining the potential of selected mutation or genetic engineering of microorganisms to detoxify hazardous waste, and contaminated soils, lagoons or groundwaters. Also, enzymes may catalyze slow chemical reactions for treating pollutants. (See W88-01298 thru W88-01318) (Lantz-PTT)
W88-01297

HAZARDOUS WASTE DETOXICATION AT CONTRACT WASTE MANAGEMENT FACILITIES,
IT Enviroscience, Concord, CA.
C. Youngson, and J. Ferriera.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 3-39, 8 fig, 3 tab, 1 ref.

Descriptors: *Hazardous wastes, *Waste treatment, *Detoxification, *Detoxication, *Wastewater treatment, Wastewater facilities, Air stripping, Steam stripping, Chemical treatment, Solvents, Incineration, Carbon adsorption, Sludge drying.

The present detoxification technologies of the Northern California Treatment System Complex (NCTSC) facility include air/steam stripping, chemical treatment, solvent recovery, oil reprocessing and incineration. Detoxification technologies for the future Ascension Parish Hazardous Waste Management Facility (APHWMF) include steam stripping, carbon adsorption, solvent extraction, chemical treatment, sludge dewatering/drying, chemical recovery, incineration, stabilization and wastewater treatment. The technologies planned for future facilities are extensions or improvements of those currently used. For example, the steam stripper for the future facility performs a function similar to the air/steam sparging system of the current facility, but is much more efficient. Similarly, the solvent recovery system of the future facility is much more efficient and sophisticated than that of the present solvent recovery system. In addition, the integrated nature of the future facility is an extension of the current facility, since such integration is essential to applying waste detoxification technologies economically to hazardous waste management on a contract basis. (See also W88-01297) (Lantz-PTT)
W88-01298

CHEMICAL PROCESSES IN THE INCINERATION OF HAZARDOUS MATERIALS,
National Bureau of Standards (NML), Washington, DC. Chemical Kinetics Div.
W. Tsang, and W. Shaub.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 41-59, 5 fig, 7 tab, 23 ref.

Descriptors: *Detoxification, *Waste treatment, *Hazardous wastes, *Wastewater treatment, *Chemical treatment, *Incineration, Chemical reactions, Chemical properties, Thermodynamics.

A qualitative picture of how a large polyatomic molecule breaks down under incinerator conditions is given from the point of view of elementary processes. Attempts are made to make these concepts quantitative, first in terms of thermodynamic equilibrium and then from a more detailed consideration of the rates (or at least the relative rates) of the pertinent elementary processes. Particular attention is paid to sources of data and the availability of estimation schemes. These concepts will be applied to chemicals that are of interest in a hazardous waste context. Finally, a number of unanswered questions are listed, and certain types of experiments are suggested that will help provide a proper methodology and data base for design and

operational purposes in the incineration of hazardous wastes. (See also W88-01297) (Lantz-PTT)
W88-01299

COMBUSTION CHARACTERISTICS OF CHLORINATED HYDROCARBONS,
Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.
S. M. Senkan.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 61-92, 11 fig, 3 tab, 38 ref. EPA Grant No. R 808314010.

Descriptors: *Waste treatment, *Incineration, *Wastewater treatment, *Detoxification, *Chlorinated hydrocarbons, *Combustion, Hazardous wastes, Chemical treatment, Chemical reactions, Thermodynamics, Incineration.

Although the fundamental combustion characteristics of chlorinated hydrocarbons (CHC) are not understood sufficiently well to make definitive predictions on the chemistry, mechanism and rates of CHC oxidation, some general characteristics can still be established. Available information indicates that CHC combustion is relatively fast at low temperatures and relatively slow at moderately high temperatures when compared to conventional (nonchlorinated) hydrocarbon combustion. Therefore, higher temperatures and/or longer residence times are needed to ensure complete destruction of CHC compounds in practical combustion systems. Limited research also indicates that potential for soot and particulate formation in chlorinated hydrocarbon systems is again greatly enhanced when compared to that of conventional hydrocarbons. Because of this, new constraints on excess air requirements must be considered in the design and operation of reliable incinerators. In the design of practical systems the combustion of original chlorinated hydrocarbon compounds and their decomposition products must be considered. Some chlorinated compounds can produce intermediate species that are more stable than the parent CHC molecules, and this possibility must not be overlooked. (See also W88-01297) (Lantz-PTT)
W88-01300

IMPACT OF THE RESOURCE CONSERVATION AND RECOVERY ACT ON THE DESIGN OF HAZARDOUS WASTE INCINERATORS,
IT Enviroscience, Inc., Knoxville, TN.
For primary bibliographic entry see Field 6E.
W88-01301

USING SOLIDIFICATION AS A WASTE DETOXICATION PROCESS,
Weston (Roy F.), Inc., Woburn, MA.
R. B. Pojasek.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 109-115.

Descriptors: *Waste treatment, *Waste disposal, *Solidification, *Wastewater treatment, *Detoxication, Chemical treatment, Quicklime, Thermodynamics, Waste management.

Solidification has not widely been thought of as a detoxification process. Some may argue that this process simply prepares a waste for landfilling in a secure facility. However, solidification has been used successfully for waste detoxification for more than ten years. There are many feasible solidification processes. These processes are either commercially (i.e., privately owned) or generically available. They can be utilized at the waste generation site or at a waste management facility offsite. There are even mobile solidification units available for use at uncontrolled waste sites or inactive lagoons. This versatility may account for the recent reawakening in interest for this often misunderstood technology. Solidification is not a disposal technique. Beyond the physical encapsulation properties that are inherent in most processes, some processes chemically bind or 'fix' certain inorganic species to the crystalline matrix. The quicklime process generates great heat, thereby disinfecting (i.e., through biological process) or even thermally oxidizing organics. Finally, asphalt processes may account for significant volume reduction. This chapter examines how the treatment process of solidification leads to detoxification. (See also W88-01297) (Lantz-PTT)
W88-01302

TREATMENT AND DESTRUCTION OF POLYCHLORINATED BIPHENYLS AND POLYCHLORINATED BIPHENYL-CONTAMINATED MATERIALS,
Acurx Waste Technologies Corp., Cincinnati, OH.
L. Weitzman.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 131-142, 2 tab, 11 ref.

Descriptors: *Waste treatment, *Wastewater treatment, *Polychlorinated biphenyls, *Detoxification, *Hazardous wastes, *Incineration, Chemical treatment, Oxidation, Dechlorination, Liquid-phase destruction, Public opinion.

Polychlorinated biphenyls (PCB) were among the earliest classes of compounds to be identified as hazardous and to be banned by law. As such, they have become in many people's minds the epitome of 'hazardous waste.' This has made them difficult to control and manage safely. Because of the uncertainty and fear generated by the present attitude toward PCB, there is a shortage of facilities available for their legal disposal or destruction. The legal, technical and regulatory status of PCB and their control were examined. The various technologies available for their destruction are examined from viewpoints of efficacy and potential for solution of these problems. The specific combustion technologies discussed are: liquid injection incinerators, rotary kiln incinerators, high-efficiency boilers (for 50 to 500-ppm PCB), cement kilns, fluidized bed incinerators, molten salt incinerators, pyrolysis, and ocean based incineration. In addition to combustion technologies, chemical technologies (including wet oxidation and chemical dechlorination), and exotic technologies (such as microwave plasma destruction) are also discussed. There are many technologies that appear capable of destroying PCB. The problems that are usually encountered, however, are rarely technical. In almost every case considered, the problem has been public acceptance of the disposal facility, with objections falling into three categories: (1) exposure of new people to a (perceived) rise, (2) inability to verify destruction during normal operation, and (3) fear of dispersion of pollutants. Liquid-phase destruction systems appear to embody those attributes that best satisfy the above criteria. These methods appear to stand the best chance of being accepted by the public and of solving the disposal problems associated with PCB. (See also W88-01297) (Lantz-PTT)
W88-01304

INCINERATION OF CHEMICAL WASTES CONTAINING POLYCHLORINATED BIPHENYLS: ASSESSMENT OF TESTS CONDUCTED AT ROLLINS ENVIRONMENTAL SERVICES, DEER PARK, TEXAS, AND ENERGY SYSTEMS COMPANY, EL DORADO, ARKANSAS,
Wright State Univ., Dayton, OH. Brehm Lab.
T. O. Tiernan, M. L. Taylor, J. G. Solch, G. F. Vanness, and J. H. Garrett.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 143-184, 12 fig, 8 tab, 14 ref. EPA Contract No. CR806846-01.

Descriptors: *Waste treatment, *Wastewater treatment, *Chemical wastes, *Detoxification, *Polychlorinated biphenyls, *Texas, *Arkansas, *Incineration, Chlorinated dibenzo-p-dioxins, Chlorinated dibenzofurans, Hazardous wastes.

The resistance of polychlorinated biphenyls (PCB) to thermal degradation makes efficient incineration of these compounds quite difficult. Moreover, the possibility of interconversions of the PCB to chlorinated dibenzo-p-dioxins (CDD) and chlorinated dibenzofurans (CDF), which can occur during incineration, makes it mandatory to ensure that incineration of these compounds is accomplished under optimum conditions. In recognition of this fact, EPA has specified that incinerators used for disposing of PCB must be operated at very high temperatures. Even under such conditions, however, it has not been established that emissions of toxic compounds, such as CDD and CDF, are essentially precluded. Recently, EPA conducted test burns of PCB at two chemical waste destruction facilities in the United States in an effort to assess the efficiency of incineration as a destruction technique for PCB. The two incinerators used in these tests and the relevant operating parameters are described. In addition, the sampling and analytical procedures developed and implemented to determine levels of toxic chlorocarbons (primarily CDD/CDF) emanating from the stacks of the two incinerators during these tests are discussed. The levels of CCD/CDF that were present in the stack effluents are reported, and the results of the risk assessment for the incinerators that was accomplished by EPA using the latter data are summarized. (See also W88-01297) (Lantz-PTT)
W88-01305

ULTIMATE DISPOSAL OF POLYCHLORINATED BIPHENYLS,
Royal Military Coll. of Canada, Kingston (Ontario). Dept. of Civil Engineering.
T. G. Barton, and G. P. Arsenault.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 185-199, 5 fig, 25 ref.

Descriptors: *Waste treatment, *Waste disposal, *Polychlorinated biphenyls, *Detoxification, *Wastewater treatment, *Detoxication, Incineration, Organic compounds, Plasma systems, Dehalogenation, Chemical treatment, Monobromobenzene, Orthodibromobenzene.

Polychlorinated biphenyls (PCB) present a difficult problem for conventional waste disposal systems. They are very stable chlorinated organic molecules that require long dwell times at high temperatures to effect thermal destruction. Present incineration guidelines suggest a 2.0-sec dwell at 1200 C or a 1.5-sec dwell at 1600 C. These combinations are difficult to achieve in incinerators, yet can be easily achieved in a plasma system. However, these guidelines may be extremely conservative for a plasma system, for two reasons. First, since radiative heat transfer proceeds as a function of the fourth power of the temperature differential, a plasma system is capable of transferring energy approximately six million times faster than conventional incineration. Second, organic chlorides are known to dehalogenate when excited by ultraviolet (UV) light. It thus may be conceived that a plasma system possesses properties conducive to ultimate destruction of organic halogens such as PCB. A test was conducted to qualify this belief, and a further $400,000 test program, is under way for toxic waste destruction at the Royal Military College in Kingston, Ontario. During each test, a combination of 4- and 9-in.-diameter impingers was used. Internal calibration to determine impinger trapping efficiency was conducted during each test by injecting known amounts of monobromobenzene. The large impingers were packed with 20-mm Raschig rings and contained 500 ml of ethylene glycol as a wetting agent. At the end of each test, each impinger was injected with a known quantity of orthodibromobenzene to be used as an indicator of the effectiveness of the extraction procedure. Extraction efficiency was better than 99%, and impinger trapping efficiency was comparable. (See also W88-01297) (Lantz-PTT)
W88-01306

CHEMICAL DESTRUCTION OF POLYCHLORINATED BIPHENYLS IN TRANSFORMER OIL,
General Electric Co., Schenectady, NY. Research and Development Center.
J. F. Brown, M. E. Lynch, J. C. Carnahan, and J. Singleton.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 201-214, 1 fig, 3 tab, 10 ref.

Descriptors: *Waste treatment, *Detoxification, *Wastewater treatment, *Chemical treatment,

*Polychlorinated biphenyls, *Oils, Chemical reactions, Temperature, Aroclor, Sodium, Anions, Benzophenone, Naphthalene, Diglyme.

One consequence of the restrictions on the use of polychlorinated biphenyls (PCB) enacted into law by Congress in 1976 and subsequently promulgated into regulation by the U.S. Environmental Protection Agency (EPA) has been to create a need for nearly total removal of trace level PCB from some still uncertain fraction of the 1.5 billion gallons of specially refined mineral oil (10C oil) currently in use in U.S. transformers. A known generic approach to selective destruction of aromatic chlorides like PCB in hydrocarbon media at low temperatures consists of treatment with reactive anion radicals, formed by interaction of sodium metal with an electron carrier in an aprotic cation-complexing solvent or as an intermediate in a free radical chain reaction. Experimental evaluation of the interactions of a number of sodium/electron carrier/solvent systems with 10C oils containing 125-800 ppm of Aroclor 1254 or 1260 showed that most of the sodium adduct was consumed by reaction with the 10C oil rather than with PCB, particularly when only low levels of ion-complexing solvent were present. Marked reductions in solvent requirements could be achieved, however, by forming the presumed adduct in situ, e.g., by simply stirring together the PCB-containing oil, finely dispersed sodium, catalytic quantities of an electron carrier (such as benzophenone or naphthalene) and an ion-complexing solvent, such as diglyme (DGM). Using various specimens of PCB-containing 10C oil that had been used in transformers, removal of PCB to gas chromatographically undetectable levels (0 + or - 2 ppm) could thus be effected in simple process equipment within a few minutes at room temperature. (See also W88-01297) (Lantz-PTT)
W88-01307

LIGHT-ACTIVATED REDUCTION OF CHEMICALS FOR DESTRUCTION OF POLYCHLORINATED BIPHENYLS IN OIL AND SOIL,
Atlantic Research Corp., Alexandria, VA.
J. F. Kitchens, W. E. Jones, G. L. Anspach, and D. C. Schubert.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 215-226, 8 fig, 3 ref.

Descriptors: *Waste treatment, *Detoxification, *Light-Activated Reduction of Chemicals, *LARC, *Polychlorinated biphenyls, *Wastewater treatment, *Oil, *Soil contamination, Kepone, Ultraviolet radiation, Organic compounds, Chemical reactions, Mass spectrometry, Hydrogen, Halogenated compounds, Dehalogenation.

Atlantic Research Corporation (ARC) has addressed the problem of destruction of halogenated organics in wastes and the environment with the development of the light-activated reduction of chemicals (LARC) process. This process was originally developed for the destruction of Kepone; however, research has shown that the destruction of PCB extracted from soils and in transformer oils is economically feasible with the LARC process. LARC is a patented process that uses ultraviolet (UV) light in the 1850- to 4000-A region in combination with hydrogen gas and optimized photochemical conditions to effect dehalogenation of complex chlorinated and brominated organic molecules. UV light initiates the photochemical process by homolytic cleavage of the carbon-halogen bonds. The conditions are optimized to maximize this cleavage and the resultant formation of a carbon-hydrogen bond. Mass spectral data from LARC reactions run in deuterated solvents show that the hydrogen gas or from the solvent, depending on the solvent involved. In either case, hydrogen gas plays a significant role in the photoreduction process since the same reactions with nitrogen substituted for hydrogen proceed at much slower rates. The LARC process has been applied to reductive dehalogenation of several compounds, of which the most environmentally significant are Kepone in water and PCB from soils and in oils. Research on LARC degradation of PCB from soils and in oil conducted at ARC is discussed. (See also W88-01297) (Lantz-PTT)
W88-01308

CATALYZED WET OXIDATION OF HAZARDOUS WASTES,
IT Enviroscience, Inc., Knoxville, TN.
R. A. Miller, and R. D. Fox.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 227-232, 2 tab, 5 ref.

Descriptors: *Waste treatment, *Catalyzed Wet Oxidation, *Hazardous wastes, *Detoxification, *Wastewater treatment, Organic compounds, Oxidation, Nitrates, Bromides, Iodides, Chemical reactions, Chemical treatment.

There are a number of existing treatment methods that are capable of either completely (using expensive reagents) or partially (using an inexpensive reagent) destroying hazardous wastes. However, there is one treatment process under development that combines the advantages of a number of treatment methodologies into a system that offers the small hazardous waste generator an alternative to offsite disposal or treatment services. The process, catalyzed wet oxidation (CWO), harnesses the potential of powerful oxidizing species to oxidize organics to carbon dioxide, water and inorganic salts with the economy of using the oxidation potential of oxygen. The CWO process is based on a U.S. patent which demonstrates the use of nitrate and bromide or iodide ions in an acidic solution to catalyze the oxidation of organics by oxygen. The catalyst system originally was developed for oxidizing soluble organics in aqueous wastes, but has been modified to permit its application to insoluble organic residues. An improved catalyst system for these applications is described in another U.S. patent. CWO can destroy a wide variety of waste compounds. The process destroys organic chemicals at much lower temperatures than conventional wet oxidation systems. The milder operating conditions and resultant process design options make CWO an attractive waste treatment alternative, especially for small waste generators who wish to maintain economic and legal control of their wastes. The improvements associated with the catalysts of the wet oxidation process were achieved through an understanding of the process chemistry and the identification of limiting reactions. Subsequent improvements, such as the bromide-nitrate catalyst, not only reduced the operating conditions and treatment cost, but also expanded the list of wastes suitable for treatment by the process. As the problems of hazardous wastes and stricter government regulations are dealt with, one must look at the process chemistry to improve the performance of waste treatment. (See also W88-01297) (Lantz-PTT)
W88-01309

SELECTED LEGAL ASPECTS OF A DIOXIN DETOXICATION PROJECT,
Syntex Research, Inc., Palo Alto, CA.
For primary bibliographic entry see Field 6E.
W88-01312

PROCESS FOR DESTROYING TETRACHLORODIBENZO-P-DIOXIN IN A HAZARDOUS WASTE,
IT Enviroscience, Inc., Knoxville, TN.
J. H. Exner, J. D. Johnson, O. D. Ivins, M. N. Wass, and R. A. Miller.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 269-287, 6 fig, 18 ref.

Descriptors: *Hazardous wastes, *Wastewater treatment, *Waste treatment, *Dioxins, *Chlorinated hydrocarbons, *Tetrachlorodibenzo-p-dioxin, *Missouri, *Verona, Cleanup operations, Hexachlorophene, Photolysis, Chemical treatment, Chemical reactions.

Polychlorinated dibenzo-p-dioxins (PyCDD) are extremely toxic compounds that have been involved in several highly publicized accidents such as the Missouri Horse Arena episode in 1971, the Seveso release in 1976, and in the controversies surrounding the use of Agent Orange and trichlorophenoxyacetic acid herbicides. The 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) isomer is one of the most toxic chemicals known toward certain species of animals. In 1974, the presence of tetrachlorodibenzodioxins was confirmed in a waste storage tank at a chemical plant in Verona, Missouri. The waste resulted from production of hexachlorophene by North Eastern Pharmaceutical and Chemical Co. (NEPACCO). NEPACCO became defunct in 1971 and the tank and contents reverted to Syntex (U.S.A.) Inc. After the discovery of the contents of the tank, public and political opposition to transportation and destruction of this politically sensitive waste prevented land- or sea-based incineration. A safer method, the extraction-photolysis process was employed for destroying TCDD in a hazardous waste in full-scale operation within 19 months of initial laboratory experiments. A 3000X scaleup of data from laboratory to full-scale plant was successful. Procedures developed for handling the very toxic dioxin prevented personnel exposure and environmental contamination. None of the extensive contingency procedures needed to be implemented. About 7 kg of dioxin were destroyed with 99.94% efficiency, and a significant hazard to the population of Verona, Missouri, and surrounding communities was removed. (See also W88-01297) (Lantz-PTT)
W88-01313

ENVIRONMENTAL HEALTH AND SAFETY CONSIDERATIONS FOR A DIOXIN DETOXICATION PROCESS,
Syntex Research, Inc., Palo Alto, CA.
C. J. Sawyer.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 289-297, 1 fig, 2 tab.

Descriptors: *Environmental effects, *Dioxins, *Wastewater treatment, *Waste treatment, *Pollution treatment, *Chlorinated hydrocarbons, *Detoxification, *Waste disposal, *Hazardous wastes, Safety, Sludge, Tetrachlorodibenzo-p-dioxin, Organic compounds.

Successful, environmentally safe destruction of nearly 4300 gallons of dioxin-laden sludge containing 343 ppm of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) was a significant challenge. Syntex Agribusiness Inc. engaged the consultant services of IT Enviroscience, Inc., to help develop a unique extraction-photolysis process to remove and subsequently destroy the dioxin from a complex, tar-like sludge residue. This residue was the resultant still bottoms from a high-vacuum distillation of trichlorophenol (TCP). The material had been generated by a firm, the North East Pharmaceutical and Chemical Company (NEPACCO), which leased a portion of a chemical plant that was later purchased by Syntex. An interdisciplinary team of Syntex scientists, technical experts in environmentally health and safety, a Blue Ribbon Committee of academic and industry consultants, and several members from various governmental agencies all worked to help plan, design and refine this process. More than 13 lb of dioxin (343 ppm) was safely detoxified to <0.2 ppm - a reduction greater than 99.9%. Because of the known toxicity of TCDD, strictly regimented environmental, health and safety guidelines were implemented for the conduct of the process operation to ensure that the environment, workers and surrounding area were adequately protected. (See also W88-01297) (Lantz-PTT)
W88-01314

OPPORTUNITIES FOR DEVELOPMENT OF NEW DETOXICATION PROCESSES THROUGH GENETIC ENGINEERING,
Illinois Univ. at Urbana-Champaign. Inst. for Environmental Studies.
J. B. Johnston, and S. G. Robinson.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 301-314, 26 ref.

Descriptors: *Wastewater treatment, *Genetic engineering, *Detoxification, *Waste treatment, *Hazardous wastes, Literature review, Biodegra-

dation, Biological treatment, Water pollution control.

The US EPA Advanced Environmental Control Technology Research Center (AECTRC) at the University of Illinois has conducted a planning study to assess the opportunities and problems of developing new pollution control technologies using genetic engineering. The goal of this study was to document the scientific basis for the genetic engineering approach to pollution control, and to develop recommendations for a research policy to promote it. To achieve this goal, three working papers were assembled, each dealing with one of the following subjects: (1) description of problems potentially amenable to the genetic engineering approach; (2) description of the genetic engineering technologies available for creation of new solutions to these problems; and (3) selective description of factors limiting natural biodegradative processes, especially those that potentially may be manipulated by genetic engineering to create new pollution control technologies. Each of these papers was reviewed by nationally recognized experts. In May 1981 these experts were brought to the University of Illinois to participate in a workshop that was organized around a discussion of the working papers. In addition, each paper was reviewed by a number of outside scientists and engineers. Information from the AECTRC study relevant to biological detoxification of pollutants is assembled, along with comments on the genetic engineering approach and possible barriers to the development of such new treatments. (See also W88-01297) (Lantz-PTT)
W88-01315

POTENTIAL ROLE OF GENETICALLY ENGINEERED MICROORGANISMS TO DEGRADE TOXIC CHLORINATED HYDROCARBONS,
Battelle Columbus Labs., OH.
G. E. Pierce.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 315-322, 1 fig, 32 ref.

Descriptors: *Genetic engineering, *Chlorinated hydrocarbons, *Waste treatment, *Detoxification, *Microorganisms, *Wastewater treatment, *Hazardous wastes, Biodegradation, Organic compounds, Dichlorophenoxyacetic acid, Trichlorophenoxyacetic acid, DDT, Atrazine, Polychlorinated biphenyls, Biological treatment.

Microorganisms have been shown to degrade methane, fatty acids, benzene, naphthalene, and various petroleum fractions. Many synthetic compounds, such as 2,4-dichlorophenoxyacetic acid (2,4-D); 2,4,5-trichlorophenoxyacetic acid (2,4,5-T); DDT; 2-chloro-4-(ethylamino)-6-(iso-propylamino)-s-triazine (Atrazine); and some isomers of polychlorinated biphenyls (PCB) are also degraded by microorganisms. Because of several inherent problems encountered when employing microorganisms to degrade toxic chlorinated hydrocarbons, genetic engineering may benefit microbial systems in four areas: stabilization, increased activity, multiple degradative activities, and health, safety and environmental concerns. There are technical restraints or problems to achieving these goals. These restraints will be overcome as better cloning-vector systems for pseudomonads and other degradative bacteria become available. Also, with more information regarding the physiology, biochemistry and regulation of these degradative bacteria, the realization of these goals will come closer to being achieved. It must also be stated that before such successful 'engineered' microorganisms are a reality, engineering information must also be integrated and developed where necessary. (See also W88-01297) (Lantz-PTT)
W88-01316

MICROBIOLOGICAL SEPARATION FOR TRACE-ORGANICS REMOVAL,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
B. E. Rittmann, and H. Kobayashi.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 323-347, 6 fig, 6 tab, 60 ref. EPA Contract No. CR 806819.

Descriptors: *Trace organics, *Microbial degradation, *Wastewater treatment, *Waste treatment, *Detoxification, Biological treatment, Biofilms, Hazardous wastes, Bacteria, Biodegradation.

Biodegradation of anthropogenic organics present in waters is a complicated and not very well developed field. However, several factors are clear. When the contaminants are at very low concentration, special consideration must be given to providing enough energy for the bacteria to sustain themselves in the system. Biofilm processes seem most appropriate, since the bacteria are kept in the reactor by attachment, and biofilms predominate naturally with low concentrations. Secondary utilization, nonsteady-state operation, and activated carbon attachment are methods to promote bacterial growth when concentrations are very low. In combination with these three methods, fluidized-bed treatment offers advantages for obtaining very low effluent concentrations. For landfill leachate, which is often anaerobic and contains rather high organic strength, anaerobic methanogenic processes offer the benefits of decreased operating costs and enhanced degradation of many hazardous contaminants. Caution must be exercised to prevent toxicity to the anaerobic microorganisms, and post-treatment with a simple aerobic process may be necessary to polish the effluent and degrade halogenated aromatics. Although some concepts and techniques are known, much basic information about biodegradation of trace-level organics is lacking, such as: physiological response of bacteria to very low concentrations of substrates; relationship between primary and secondary substrates; toxicity of trace-level organics to biological processes; ability to apply treatment concepts to real-world applications; consequences of partial degradation; and interactions among communities of microorganisms necessary to completely degrade compounds. (See also W88-01297) (Lantz-PTT)
W88-01317

PEROXIDASE FOR REMOVAL OF HAZARDOUS AROMATICS FROM INDUSTRIAL WASTEWATERS,
Massachusetts Inst. of Tech., Cambridge. Dept. of Nutrition and Food Science.
B. N. Alberti, and A. M. Klibanov.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 349-356, 1 fig, 2 tab, 22 ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Aromatic compounds, *Detoxification, *Hazardous wastes, Chemical treatment, Horseradish peroxidase, Hydrogen peroxides, Phenol, Aniline, Organic compounds.

The treatment of wastewaters with horseradish peroxidase and H2O2 has been demonstrated to cause the precipitation of phenols, anilines and some other organics. Preliminary cost analysis indicates that this new enzymatic approach to water detoxification may be economically feasible and cost-competitive with conventional methods. (One should also note that the precipitate formed as a result of enzymatic polymerization of pollutants can, in principle, be burned and the energy obtained can be used for heating). It is hoped that as industry continues to tackle the ever-growing problem of wastewater treatment, the enzymatic process described in this work will be seen as a feasible and attractive alternative. (See also W88-01297) (Lantz-PTT)
W88-01318

BIODEGRADATION AND DETOXIFICATION OF ENVIRONMENTAL POLLUTANTS.
For primary bibliographic entry see Field 5B.
W88-01369

MICROBIAL METABOLISM AND ENZYMOLOGY OF SELECTED PESTICIDES,
Oklahoma Univ., Norman. Dept. of Botany and Microbiology.
For primary bibliographic entry see Field 5B.
W88-01370

MICROBIAL DEGRADATION OF POLYCHLORINATED BIPHENYLS (PCBS),
Fermentation Research Inst., Yatabe (Japan).
For primary bibliographic entry see Field 5B.
W88-01371

CHEMICAL TRANSFORMATIONS OF AROMATIC HYDROCARBONS THAT SUPPORT THE GROWTH OF MICROORGANISMS,
University Coll. of North Wales, Bangor. Dept. of Biochemistry and Soil Science.
For primary bibliographic entry see Field 5B.
W88-01372

GENETIC AND BIOCHEMICAL BASIS FOR MICROBIAL TRANSFORMATIONS AND DETOXIFICATION OF MERCURY AND MERCURIAL COMPOUNDS,
Washington Univ., St. Louis, MO. Dept. of Biology.
For primary bibliographic entry see Field 5B.
W88-01373

TRENDS OF GROUND WATER PROTECTION FROM WASTEWATER SLUDGE POLLUTION IN THE CITY OF MOSCOW,
For primary bibliographic entry see Field 5E.
W88-01403

SUMMARY OF GROUNDWATER POLLUTION PROBLEMS IN SOUTH DAKOTA,
South Dakota Dept. of Water and Natural Resources, Pierre.
For primary bibliographic entry see Field 5B.
W88-01406

ORIGIN AND TREATMENT OF UNDERGROUND WATERS FROM CERRO DE PASCO MINE, PERU,
Centromin Peru S.A., Lima (Peru).
For primary bibliographic entry see Field 5B.
W88-01411

HEAVY METAL CONTENT IN MACROPHYTES FROM PONDS SUPPLIED WITH POST-SEWAGE WATER,
Warsaw Univ. (Poland). Dept. of Hydrobiology.
For primary bibliographic entry see Field 5B.
W88-01464

ACCUMULATION OF HEAVY METALS IN AQUATIC ORGANISMS OF SEWAGE WATER TREATMENT PLANTS,
Hajdu-Bihar County Water Canalization Works, Debrecen (Hungary).
For primary bibliographic entry see Field 5B.
W88-01470

5E. Ultimate Disposal Of Wastes

CASE STUDY: IN SITU SOLIDIFICATION/FIXATION OF OIL FIELD PRODUCTION FLUIDS - A NOVEL TECHNIQUE,
ENRECO, Inc., Amarillo, TX.a
For primary bibliographic entry see Field 5D.
W88-00969

FIXATION OF ELECTROPLATING WASTE SLUDGES,
Missouri Univ., Columbia. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W88-00976

TREATABILITY OF DIVERSE WASTE STREAMS IN THE PACT ACTIVATED CARBON-BIOLOGICAL PROCESS,
Du Pont de Nemours (E.I.) and Co., Deepwater, NJ. Chambers Works.
For primary bibliographic entry see Field 5D.
W88-00977

CHEMICAL RESIDUE DISPOSAL WITH HEAT RECOVERY,
Union Carbide Corp., South Charleston, WV. Engineering, Mfg. and Technology Services Div.
W. G. Hudson.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 129-138, 6 tab, 3 ref.

Descriptors: *Wastewater treatment, *Wastewater disposal, *Chemical wastes, *Waste disposal, *Organic compounds, Liquid wastes, Incineration, Surveys.

A Union Carbide Corporation survey showed that 550 million pounds/yr of liquid residues were being produced by its chemical plants. To keep this survey manageable and focused on fuelable residues, it only included the liquid residue streams that met the following criteria: (a) Stream consisted of more than 20,000 pounds/yr; (b) Major components in stream were organics; and (c) Residue stream was not presently sold. Of the 550 million pounds/yr of residues produced, 475 million pounds/yr were burned in boilers or process heaters. The remaining 75 million pounds/yr were disposed of without heat recovery. This paper details reasons why the 75 million pounds/yr of residues were not burned with heat recovery. Also covered are the definitions of four classifications of residues used by Energy Systems (Utilities Department) to determine the rate of compensation to the producing units from their residues. (See also W88-00963) (Lantz-PTT)
W88-00978

WASTEWATER TREATMENT FACILITIES FOR EXXON'S NEW CORPORATE RESEARCH FACILITIES,
Exxon Research and Engineering Co., Florham Park, NJ.
For primary bibliographic entry see Field 5D.
W88-00979

STAUFFER'S UTILIZATION OF WASTE PRODUCTS AS FUEL,
Stauffer Chemical Co., Westport, CT. Sulfuric Products Div.
R. P. Miner.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 147-150, 1 tab.

Descriptors: *Waste disposal, *Fuel, *Recycling, *Waste recovery, Chemical wastes, Industrial wastes, Non-Conventional Fuel Program.

Stauffer Chemical Company of Westport, CT, has been utilizing increasing quantities of industrial waste materials as a secondary fuel since 1982. This practice results in benefits to waste generators by providing an economical and minimum-risk waste disposal service, to Stauffer by providing low-cost energy, and to the general public by offering a safe alternative to land disposal and accumulation of hazardous materials. The company's experience with the Non-Conventional Fuel program highlights the challenge of participating in a highly regulated, highly visible, and rapidly changing business environment. The development of this program, based upon the principle of strict quality control, has resulted in an increased use of harder-to-handle materials, such as sludges and moderately toxic streams. (See also W88-00963) (Lantz-PTT)
W88-00980

CHARACTERIZATION AND TREATABILITY STUDIES OF AN INDUSTRIAL LANDFILL LEACHATE (KIN-BUC I),
Rutgers - The State Univ., Piscataway, NJ.
For primary bibliographic entry see Field 5D.
W88-00997

DESTRUCTION OF PCB CONTAMINATED FUEL OIL IN AN ALUMINUM MELTING FURNACE,
Aluminum Co. of America, Davenport, IA.
For primary bibliographic entry see Field 5D.
W88-00999

ENVIRONMENTAL FEASIBILITY OF USING CREOSOTE CONTAMINATED SOIL AND SLUDGES IN ROADWAY PAVING STRUCTURES,
Alabama Univ., University. Dept. of Civil Engineering.
J. Ball, C. M. Norton, and J. W. Andrews.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 361-368, 6 fig, 2 tab, 13 ref.

Descriptors: *Pollution effects, *Recycling, *Waste disposal, *Creosote, *Roads, *Paving, *Environmental effects, *Pollutant identification, Tar, Sludge disposal, Naphthalene, Phenols, Phenanthrene, Anthracene, Leaching, Economic aspects.

In 1973, the Louisiana Department of Wildlife and Fisheries, at that time the pollution control agency, issued a Stop Order requiring that all direct discharges of unpermitted contaminated wastewater be ceased. Colfax Creosoting Company complied by constructing a one acre lagoon on the southeast side of the plant. All wastewater discharges went into the lagoon for settling of the creosote and evaporation of the water. As the RCRA regulations solidified and began to be enforced, it became apparent that the typical wood preserving plant's unlined evaporation/settling lagoon would have to be: (1) extensively modified; (2) carefully monitored and expensively insured; or (3) eliminated. In most cases, the third option is best if the company can provide alternatives for current process wastewater generation and handling practices. The final disposal method discussed here is to use the waste creosote as a roadway paving additive. Based on the results of this study, it is apparent that waste sludge from a creosote wood preserving plant could be reused as a bituminous supplement in a roadway pavement structure. Because of a compatability problem, the sludge would have to be used in a road tar pavement system rather than an asphalt structure. Marshall stability tests indicate that up to 75% of the road tar portion of the mix can be substituted without a detrimental structural effect using the sludges from this study. EP toxicity tests detected four creosote constituents leached from the roadway samples at detectable significant concentrations. These constituents were naphthalene, phenol, phenanthrene, and anthracene. An economic analysis estimated a significant difference in savings in favor of reuse of the sludge in a pavement structure as opposed to disposal in-place or removal to a hazardous waste landfill. (See also W88-00963) (Lantz-PTT)
W88-01000

NEW TYPE OF ANAEROBIC DESIGN FOR ENERGY RECOVERY AND TREATMENT OF LEACHATE WASTES,
Black and Veatch, Kansas City, MO.
For primary bibliographic entry see Field 5D.
W88-01001

VOLUME REDUCTION OPTIONS FOR INSTITUTIONAL RADIOACTIVE WASTES,
Bechtel Corp., Oak Ridge, TN.
For primary bibliographic entry see Field 5D.
W88-01002

SMALL-SCALE FIELD EVALUATIONS OF LAND TREATMENT OF AN OILY HAZARDOUS WASTE,
Robert S. Kerr Environmental Research Lab., Ada, OK.
For primary bibliographic entry see Field 5D.
W88-01008

THERMAL DESTRUCTION OF IGNITABLE HAZARDOUS WASTE. A CASE STUDY IN REGULATORY INTERPRETATION,
Weston (Roy F.), Inc., West Chester, PA.
R. J. Schoenberger, M. H. Corbin, S. J. Wittmer, and A. L. Lenthe.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 447-452, 6 tab.

Descriptors: *Incineration, *Hazardous wastes, *Case studies, *Regulations, *Waste disposal, Energy, Permits.

Destruction of ignitable hazardous waste in a manufacturing facility has been subject to some changing regulatory interpretation during review of the RCRA Part B application. A compilation of the major steps followed during the review of the application is: (1) Part B application submittal; (2) Completeness review by EPA; (3) Response to completeness deficiencies; (4) Technical review by EPA; (5) Response to technical issues; (6) Draft permit; (7) Public hearing; and (8) Issue permit. The steps of greatest impact were No. 2 and No. 4. It was found the EPA overlapped their functions and often technical interpretation was included in the Completeness check. As the review process progressed, several significant policies evolved which effect the on-site thermal destruction of ignitable hazardous waste: (1) The amount of tramp halogenated material allowed in the ignitable waste is subject to regulatory interpretation; (2) An incinerator burning only ignitable waste for energy recovery can be permitted according to reduced permit requirements and without the need for a test burn; and (3) The energy recovery exclusion was denied because a bypass existed around a waste heat boiler. Denial of the energy exemption caused the unit to be classified as an incinerator. (See also W88-00963) (Lantz-PTT)
W88-01009

LIABILITY FOR PERSONAL INJURY DAMAGES: A NEW PROBLEM FOR INDUSTRIAL WASTE GENERATORS,
Brown and Caldwell, Pasadena, CA.
For primary bibliographic entry see Field 6E.
W88-01010

IRON CONDITIONING OF SLUDGE FROM FOUNDRY FURNACE EMISSION CONTROL SYSTEMS FOR ELIMINATION OF EP TOXICITY,
Residuals Management Technology, Inc., Madison, WI.
For primary bibliographic entry see Field 5D.
W88-01016

BIOLOGICAL REMOVAL AND CHEMICAL RECOVERY OF METALS FROM SLUDGES,
Toronto Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W88-01017

METAL RECOVERY FROM WASTE SLUDGES,
Recycle Metals, Glastonbury, CT.
For primary bibliographic entry see Field 5D.
W88-01019

INVESTIGATION OF FLUORIDE REMOVAL FROM SEMICONDUCTOR WASTEWATER USING WATER SOFTENING SLUDGE,
Millipore Corp., Bedford, MA.
For primary bibliographic entry see Field 5D.
W88-01049

GEOTHERMAL WASTEWATER TREATMENT AND DISPOSAL,
Collins and Ryder Consulting Engineers, Larkspur, CA.
For primary bibliographic entry see Field 5G.
W88-01052

APPLICATION OF NEW TECHNOLOGIES TO LIVESTOCK WASTE MANAGEMENT,

National Fertilizer Development Center, Muscle Shoals, AL.
For primary bibliographic entry see Field 5D.
W88-01122

RURAL ISSUES: NONCOAL MINING AND ABANDONED LAND RECLAMATION,
AMAX Chemical Corp., Lakeland, FL.
G. Uebelhoer.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 337-339.

Descriptors: *Mine wastes, *Land reclamation, *Florida, *Waste disposal, Phosphates, Sand, Silica, Clays, Dewatering, Settling basins.

In the heart of central Florida, about midway between Disneyworld and the Gulf Beaches, lies the largest concentrated deposit of phosphate rock in the world. It is called the Bone Valley Formation. It lies within 30.48 m (100 ft) of the land surface. 23 mines operating within the Bone Valley area produce 42 to 45 million tons of phosphate rock per year. Recovery of the phosphate rock from the ore, or matrix, is conducted in a central beneficiation plant where two types of product and two types of waste are produced. The waste products consist of silica sand separated from the phosphatic sands in a flotation process. The silica sand is traditionally 99.9% silica, dewaters very rapidly, is very permeable when compared to the other waste product, approximates the overburden permeability, and does not possess favorable agronomic potential. The other waste product is a mixture of clays usually consisting of montmorillonite, attapulgite, and some kaolinite. The clays dewater very slowly, are very impermeable, but possess very favorable agronomic characteristics when compared to the virgin or unmined overburden or the sand waste product. Sand disposal as construction material and soil amendments are popular. However, some mines also admix clay to the sand tailings to improve its dewatering characteristics and the pumping characteristics of the sand tailings. The typical sand/clay disposal process consists of pumping a 3% solids clay slurry to large clay settling areas, allowing the clays to settle through gravity from 3% solids to approximately 30% solids, and then revegetating the surface after dewatering is complete. Reclamation programs consisting of land and lakes involve regrading spoil piles without adding waste products. The resulting lakes with undulating shorelines and a variety of depths are surrounded by shorelines and uplands used for pasture, silviculture, citrus and intensive agricultural uses, and residential and commercial uses. (See also W88-01083) (Lantz-PTT)
W88-01145

TECHNIQUES FOR INDUSTRIAL POLLUTION PREVENTION: A COMPENDIUM FOR HAZARDOUS AND NONHAZARDOUS WASTE MINIMIZATION,
North Carolina State Univ., Raleigh. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5G.
W88-01197

NEW LOOK AT FORECASTING NATURAL PROCESSES,
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 6A.
W88-01251

ULTIMATE DISPOSAL OF POLYCHLORINATED BIPHENYLS,
Royal Military Coll. of Canada, Kingston (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W88-01306

ENVIRONMENTAL HEALTH AND SAFETY CONSIDERATIONS FOR A DIOXIN DETOXICATION PROCESS,
Syntex Research, Inc., Palo Alto, CA.
For primary bibliographic entry see Field 5D.
W88-01314

HAZARDOUS WASTE DISPOSAL: ASSESSING THE PROBLEM.
Ann Arbor Science, Ann Arbor, MI. 1982. 332 p. Edited by Joseph H. Highland.

Descriptors: *Hazardous wastes, *Path of pollutants, *Waste management, *Waste disposal, *Water pollution effects, *Water law, Landfills, Waste dumps, Monitoring, Environmental effects, Cleanup, Decontamination, Case studies, Groundwater pollution, Fate of pollutants, Water pollution sources, Public health.

A conference on hazardous waste was held in Washington, DC in December 1980. Speakers from academia, government, industry, labor, and the private sector presented papers on topics that addressed a number of crucial issues in hazardous waste management and that are arranged into six sections in this book. Section 1 focuses on four existing dump sites that represent different types of problems in terms of environmental pollution and possible threats to public health. Sections 2 and 3 present detailed discussions of our current technical ability to assess environmental impact at various sites and monitor and assess health impacts in communities around sites. Section 4 addresses the issue of protecting workers involved in cleanup of these waste sites, and Section 5 deals with technical aspects of cleanup, from onsite containment to excavation and removal. Section 6 discusses groups that may be capable of responding to the problems defined such as state, federal and local governments, industry, the private sector, and the medical community. (See W88-01376 thru W88-01400) (Geiger-PTT)
W88-01375

LESSON OF LOVE CANAL,
New York State Dept. of Health, Albany. Div. of Labs. and Research.
For primary bibliographic entry see Field 5C.
W88-01376

ASSESSING THE PROBLEM -- LOVE CANAL,
Roswell Park Memorial Inst., Buffalo, NY. Dept. of Molecular Biology.
For primary bibliographic entry see Field 5C.
W88-01377

TECKOMATORP, SWEDEN -- WASTE PROBLEMS FROM THE PERSPECTIVE OF A MANUFACTURING INDUSTRY,
Skane County Environmental Office, Malmo (Sweden).
For primary bibliographic entry see Field 5G.
W88-01379

ASSESSMENT OF THE CHURCH ROCK URANIUM MILL TAILINGS SPILL: A STRATEGY FOR EVALUATING HEALTH RISKS FROM NUCLEAR FUEL CYCLE ACCIDENTS,
Centers for Disease Control, Atlanta, GA.
For primary bibliographic entry see Field 5C.
W88-01380

ANSWER TO ASSESSING HAZARDOUS WASTE PROBLEMS IS COOPERATION,
Occidental Chemical Co., Lathrop, CA. Environmental, Health and Safety.
For primary bibliographic entry see Field 5G.
W88-01382

LOVE CANAL: ENVIRONMENTAL STUDIES,
New York State Dept. of Health, Albany. Div. of Labs. and Research.
For primary bibliographic entry see Field 5B.
W88-01383

SALSBURY LABORATORIES - LA BOUNTY SITE: A PHASED APPROACH TO A HAZARDOUS WASTE DISPOSAL PROBLEM,
National Enforcement Investigations Center, Denver, CO.
For primary bibliographic entry see Field 5G.
W88-01384

REPORT ON CMA'S INVESTIGATION OF THE LIPARI LANDFILL,
Chemical Manufacturers Association, Washington, DC.
For primary bibliographic entry see Field 5C.
W88-01385

PERIPHERAL NERVE DAMAGE IN AFFECTED POPULATIONS,
State Univ. of New York at Buffalo, Amherst.
For primary bibliographic entry see Field 5C.
W88-01386

CENTERS FOR DISEASE CONTROL'S HUMAN HEALTH ASSESSMENT APPROACH INVOLVING IMPROPERLY DISPOSED CHEMICAL WASTE,
Centers for Disease Control, Atlanta, GA.
For primary bibliographic entry see Field 5C.
W88-01387

PUBLIC HEALTH IMPLICATIONS OF ILLEGAL DUMPING OF TOXIC WASTES,
Health and Hospitals of the City of Boston, Inc., MA.
For primary bibliographic entry see Field 5C.
W88-01388

METHODS FOR ASSESSING HEALTH RISKS IN POPULATIONS LIVING NEAR HAZARDOUS WASTE SITES,
Roswell Park Memorial Inst., Buffalo, NY.
For primary bibliographic entry see Field 5C.
W88-01389

EFFECTS OF ENVIRONMENTAL POLLUTANTS ON ENAMEL HYPOPLASIA AND DENTAL ATTRITION,
Meharry Medical Coll., Nashville, TN. School of Dentistry.
For primary bibliographic entry see Field 5C.
W88-01390

PROTECTING THE WORKER: AN OVERVIEW OF THE PROBLEM,
American Federation of Labor and Congress of Industrial Organizations, Washington, DC.
For primary bibliographic entry see Field 5G.
W88-01391

OCCUPATIONAL EXPOSURE MONITORING OF WORKERS AT HAZARDOUS WASTE SITES,
National Inst. for Occupational Safety and Health, Cincinnati, OH. Health Hazard and Technical Assistance Branch.
For primary bibliographic entry see Field 5C.
W88-01392

MEDICAL SCREENING OF WORKERS AT HAZARDOUS WASTE DISPOSAL SITES,
National Inst. for Occupational Safety and Health, Cincinnati, OH. Health Hazard and Technical Assistance Branch.
For primary bibliographic entry see Field 5C.
W88-01393

BRITISH EXPERIENCE-CLEAN UP: TECHNICAL ASPECTS,
UKAEA Atomic Energy Research Establishment, Harwell (England).
For primary bibliographic entry see Field 5G.
W88-01394

REMEDIAL SITE CONTAINMENT,
Conestoga-Rovers and Associates, Waterloo (Ontario).

For primary bibliographic entry see Field 5G.
W88-01395

RESPONSE CAPACITY -- STATE GOVERNMENT,
California Dept. of Health Services, Sacramento.
For primary bibliographic entry see Field 5G.
W88-01396

TOXIC WASTE PROBLEMS -- THE RESPONSE CAPACITY OF THE MEDICAL COMMUNITY,
Wayne State Univ., Detroit, MI.
J. D. Sherman.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 217-221.

Descriptors: *Waste disposal, *Toxic wastes, *Hazardous wastes, *Public health, *Education, *Toxicity, Environmental effects, Liability, Carcinogens, Water pollution effects, Human pathology.

It is suggested that the medical community, with a few exceptions in government and private practice, has not been responsive nor responsible in recognizing, diagnosing, and treating toxic chemical effects. Several recommendations are made to remedy the situation. High school and college students should be educated as to the existence of chemicals with toxic effects, and to the magnitude of the problem. Medical and science students should be educated as to specific medical problems involving toxic chemicals. A continuing education effort must be required of all practicing physicians. Corporate physicians have a special responsibility to review every chemical used in each plant under their province, and to keep meaningful epidemiological data on workers and the environment. A national clearing house should be set up for obtaining data on adverse effects of special chemicals, preferably with either a toll-free number or with computer capabilities in each state or major area. National registries should be established for cancer, birth defects, failure of pregnancies, suspected and proven specific toxicities, and maps of all known and suspected toxic dump sites with information as to what is buried at each site. Air, water, and soil near toxic dump sites should undergo regular monitoring and the results should be made known to the public. It should also be publicized that it is economically less-costly to prevent chemically-related diseases, rather than clean up dispersed toxic chemicals. (See also W88-01375) (Geiger-PTT)
W88-01397

EMERGENCY RESPONSE AND PUBLIC HEALTH AT HAZARDOUS WASTE SITES,
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 5G.
W88-01398

HAZARDOUS WASTE MANAGEMENT - THE SHARING OF RESPONSIBILITY,
Union Carbide Corp., Washington, DC.
R. F. Kelley.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 228-233.

Descriptors: *Hazardous wastes, *Toxic wastes, *Public health, *Waste disposal, *Waste management, *Environmental effects, Legal aspects, Liability, Cleanup, Training, Safety, Monitoirng, Regulations.

The government, industry, and the public must share in the responsibility for the creation of hazardous wastes because they all depend upon or have grown accustomed to the products which generate these wastes. The chemical industry has been at work finding better and improved ways to manage solid wastes long before the nation recognized the need for better waste disposal methods. To eliminate wasteful processes, the chemical industry is working hard to make its plants and production processes more efficient. Industry has also been attempting to build secure landfills to prevent leaching of hazardous wastes. As chemical companies develop new disposal equipment and methodology, they share this knowledge with others in industry, government and the public. Some chemical companies operate exchanges for toxic wastes so that one company's waste products may become another company's raw materials. The government is responsible for ensuring that the public is aware of environmental situations which are likely to have serious adverse health effects. The Thomas panel has argued that the New York Health Department was misleading and unnecessarily frightening the public when it reported on the Love Canal incident. The Thomas Panel recommended that the federal Centers for Disease Control or the National Insitute of Environmental Health Sciences take charge of such health studies involving hazardous waste dumps in the future. The media should be used as a constructive tool in obtaining safe and appropriate hazardous waste disposal sites. (See also W88-01375) (Geiger-PTT)
W88-01399

ENVIRONMENTAL ENFORCEMENT: CHANGING THE CORPORATE MIND,
Office of the Associate Attorney General, Washington, DC. Land and Natural Resources Div.
A. Z. Roisman.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 234-243.

Descriptors: *Waste disposal, *Hazardous wastes, *Toxic wastes, *Cleanup, *Waste management, *Public health, Project planning, Site selection, Public participation, Liability, Environmental effects, Industrial wastes, Landfills, Solid waste disposal, Water law.

In order for laws to be effective in getting industries to clean up their abondoned dump sites, the companies involved have to want to cooperate. If citizens see that industry is sincere in trying to protect public health and the environment, than they will be more willing to accept a secured hazardous waste dump in their community. Citizens must be involved from the very beginning in the siting of a hazardous waste dump. The public must be provided with substantial monies to hire independent technical experts to evaluate every opinion that is pesented on toxic waste issues. The site that is selected must have a major monitoring program associated with it. A massive unlimited insurance program must accompany the building of toxic waste landfills so that if something does go wrong, there is a guarantee that the money is already there to take care of the problem. The EPA implemented the Resource Conservation and Recovery Act Permit Program which required companies to obtain permits to stay in business. The EPA has the authority to issue administrative orders to require the clean up of hazardous wastes dump sites without ever having to go to court. Congress amended the Resource Conservation and Recovery Act to add larger criminal potential, or bring an action for criminal liability against a hazardous waste dumper or corporation which has operated in violation of material conditions of it's permit. The Superfund legislation has provided monies for the cleanup of hazardous waste dumps. The job of the lawyer in interpreting these laws to protect the public and the environment is discussed. (See also W88-01375) (Geiger-PTT)
W88-01400

TRENDS OF GROUND WATER PROTECTION FROM WASTEWATER SLUDGE POLLUTION IN THE CITY OF MOSCOW,
A. S. Matrosov.
United Nations, Economic Commission for Europe, WATER/SEM.14/R.7, March 2, 1987. 12 p, 5 tab.

Descriptors: *Wastewater treatment, *Sludge disposal, *Water pollution prevention, *Moscow, *Land disposal, Sludge conditioning, Groundwater pollution, Nonpoint pollution sources, Water quality control, Dewatering, Sludge drying, Sludge digestion.

The production of large amounts of sludge by Moscow's three sewage treatment plants caused the necessity of solving the problems of sludge disposal and utilization. The main trends of sludge utilization are: its application in agriculture; generation of gaseous products utilized as fuel; and incineration with subsequent heat utilization and ground disposal of cinder. In all three processes of sludge treatment and utilization, the total bulk of sludge comes into contact with soil on significant land areas. The potential danger of groundwater pollution with certain sludge components from the named non-point sources is taken into account in the process of designing and operating sludge treatment and agricultural utilization facilities. To prevent any unfavorable sludge impact on soil and groundwaters certain protective measures are carried out at Moscow activated sludge plants for the agricultural utilization of sludge. The discharge of toxic substances contained in industrial effluents to the city sewerage system are regulated and thereby reduced. Sludge beds which form a part of sludge treatment facilities must be located on grounds not less than 1.5 meters from the groundwater level. Observation wells are located along the site perimeter to control the groundwater height and its physicochemical and bacteriological composition. In areas where the aquifers are unprotected, sludge beds have asphalt-concrete shields of 30 cm thickness and an accompanying drainage system. Dewatering is carried out to ensure the improvement of sludge utilization properties and land resources saving. Sludge heat treatment ensures high sanitary reliability. Filter pressing provides more deep sludge dewatering. Sludge from the Moscow plants is transported by river from special storage facilities that minimize ground and river pollution at the point of sludge shipment. Each lot of the transported sludge is supplied with a certificate containing sludge characteristics that may be used to estimate its land application rate. (Geiger-PTT)
W88-01403

SUMMARY OF GROUNDWATER POLLUTION PROBLEMS IN SOUTH DAKOTA,
South Dakota Dept. of Water and Natural Resources, Pierre.
For primary bibliographic entry see Field 5B.
W88-01406

5F. Water Treatment and Quality Alteration

COST EFFECTIVE TREATMENTS OF OIL FIELD PRODUCED WASTEWATER FOR 'WET STREAM' GENERATION - A CASE HISTORY,
Brown and Root Development, Inc., Houston, TX.
For primary bibliographic entry see Field 5D.
W88-00966

REVERSE OSMOSIS TREATMENT OF DRINKING WATER,
Tennessee Technological Univ., Cookeville.
T. N. Eisenberg, and E. J. Middlebrooks.
Butterworths, Boston, MA. 1986. 271 p.

Descriptors: *Reverse osmosis, *Water treatment, *Desalination, *Drinking water, *Water treatment facilities, Membrane processes, Maintenance, Design criteria, Organic compounds, Inorganic compounds, Disinfection, Cost analysis, Desalination apparatus, Separation techniques.

This book is intended to meet the needs of consulting engineers, regulatory agencies, water utilities currently using or planning to use reverse osmosis, and anyone interested in reverse osmosis or the treatment of drinking water. Chapter 1 presents a general and elementary theoretical description of reverse osmosis, a short history of its development, and a look at current usage. Chapters 2 through 5 focus on removal of organics, inorganics, and microorganisms by reverse osmosis and a meeting the National Interim Primary Drinking Water Regulations. A summary of the pros and cons of contaminants removal is presented at the close of each chapter. Chapters 6 and 7 discuss the different types of reverse osmosis membranes and modules,

and the operational factors affecting reverse osmosis performance. Chapters 8 and 9 present information on cleaning and maintenance of membranes and necessary pretreatment of feedwater for reverse osmosis systems. Chapter 10 contains a survey of reverse osmosis installations with information on design, operation, and maintenance. Chapter 11 reviews approval and design criteria of regulatory agencies, and Chapter 12 deals with the economics and costs of reverse osmosis and a comparison of reverse osmosis with other desalting technologies. Chapter 13 presents a look at the future of reverse osmosis in the treatment of drinking water. (Geiger-PTT)
W88-01493

5G. Water Quality Control

PHYSICOCHEMICAL TREATMENT OF WASHRACK WASTEWATER,
Camp, Dresser and McKee, Inc., Atlanta, GA.
For primary bibliographic entry see Field 5D.
W88-00964

JOINT WASTEWATER MANAGEMENT FOR A CLUSTER OF TANNERIES AT KANPUR,
Indian Inst. of Tech., Bombay. Centre for Environmental Science and Engineering.
For primary bibliographic entry see Field 5D.
W88-00981

TREATMENT OF ACID MINE WATER DISCHARGING INTO THE TAR CREEK WATERSHED,
Oklahoma State Univ., Stillwater. School of Civil Engineering.
For primary bibliographic entry see Field 5D.
W88-00985

BIOLOGICAL TREATMENT REQUIRED FOR CLEANUP OF CONTAMINATED GROUND WATER AT A HAZARDOUS WASTE DUMP SITE,
Environmental Engineering Consultants, Inc., Stillwater, OK.
For primary bibliographic entry see Field 5D.
W88-00993

CASE STUDIES INVOLVING THE TREATMENT OF HAZARDOUS SUBSTANCES UNDER THE SUPERFUND REMEDIAL ACTION PROGRAM,
Environmental Protection Agency, Washington, DC. Remedial Response Control.
For primary bibliographic entry see Field 5D.
W88-00995

BIOLOGICAL TREATMENT OF A BRINE GROUNDWATER CONTAMINATED WITH HIGH CONCENTRATIONS OF ORGANICS,
DETOX, Inc., Dayton, OH.
For primary bibliographic entry see Field 5D.
W88-00996

CHARACTERIZATION AND TREATABILITY STUDIES OF AN INDUSTRIAL LANDFILL LEACHATE (KIN-BUC I),
Rutgers - The State Univ., Piscataway, NJ.
For primary bibliographic entry see Field 5D.
W88-00997

NEW TYPE OF ANAEROBIC DESIGN FOR ENERGY RECOVERY AND TREATMENT OF LEACHATE WASTES,
Black and Veatch, Kansas City, MO.
For primary bibliographic entry see Field 5D.
W88-01001

POLLUTION PREVENTION PAYS (3P). 3M'S RESPONSE TO INDUSTRIAL WASTE CONTROL,
Minnesota Mining and Mfg. Co., St. Paul.
S. J. Zoss, and M. D. Koenigsberger.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 459-461, 1 tab.

Descriptors: *Water pollution prevention, *Minnesota Mining and Manufacturing, *Industrial wastes, *Waste treatment, *Wastewater treatment, Water quality control, Recycling, Process design, Economic aspects, Waste management, Waste disposal.

In late 1974, 3M established a special program to encourage its scientists, engineers, and other concerned employees to develop low or nonpollution technologies to resolve its environmental problems. This program was called the 'Pollution Prevention Pays' or the '3P' Program, for short. This effort has been in effect since 1975 and centers around four areas of activities which are: product reformulation, process modification, equipment redesign, and recovery of waste materials for reuse. By eliminating pollution at the source, end-or-pipe treatment is unnecessary and valuable materials can be recovered. Thus, pollution prevention can pay for itself. The 3P Program was established to achieve an improved environment; reduced capital and operating costs for pollution control facilities; reduced material and energy costs; increased sales of products with reduced pollution potential; and spin-off technologies, perhaps leading to commercial development of new products. From 1975 through 1983, the program has generated a total savings of $191 million. This includes $155 million from U.S. operations and $36 million from 20 international operations. The program has produced more than 1,000 projects since its initiation. The program also has produced significant reductions in the amount of pollution generated by 3M manufacturing facilities worldwide. Examples of 3P projects are: product formulation, process modification, equipment redesign, and recycling and reuse. (See also W88-00963) (Lantz-PTT)
W88-01011

TREATMENT OF HIGH STRENGTH WASTEWATER CONTAINING ORGANIC SOLVENTS,
Woodard and Curran, Gorham, ME.
For primary bibliographic entry see Field 5D.
W88-01038

SELECTION OF STATISTICALLY APPROPRIATE COMPLIANCE SAMPLING INTERVALS,
Environmental Resources Management-North Central, Inc., Palatine, IL.
R. O. Ball, and C. A. Vath.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 853-859, 4 fig, 5 tab, 2 ref.

Descriptors: *Wastewater management, *Water quality control, *Statistical studies, *Compliance standards, *Water sampling, Monitoring, Wastewater discharge, Regulations.

Environmental discharges are rarely constant or completely predictable. This is especially true in industrial wastewater discharges either as direct discharges under NPDES or indirect discharges to public operated treatment works. The use of statistical procedures in the selection of appropriate sampling intervals is important to ensure that the measured values truly represent the overall discharge characteristics. This is especially significant when a limited number of samples per sampling interval are taken. The problems presented by batch or semi-continuous production cycle wastewater dischargers with respect to compliance sampling are analyzed, and a methodology for the selection of statistically appropriate compliance sampling intervals is provided. While this methodology can be used for direct discharges, the paper focuses on the use for indirect dischargers who face a user based upon the results of compliance sampling by the industry (self-monitoring) or a second party (such as a sanitary district). (See also W88-00963) (Lantz-PTT)
W88-01050

TWENTY YEARS OF RESPIROMETRY,
Arthur Technology, Inc., Fond du Lac, WI.
R. M. Arthur.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 861-874, 21 fig, 23 ref.

Descriptors: *Wastewater treatment, *Analytical methods, *Respirometry, *Water quality control, *History, Monitoring, Measuring instruments, Biological oxygen demand, Respirometers, Automation, Toxicity, Process control.

The history of automated large volume respirometry from 1964 to 1984 has been a circular path. Initial emphasis in application was on correlation with BOD. During the middle years emphasis was on use in toxicity-treatability testing and in process control. And now at the end of this twenty year period a new emphasis has been placed on BOD correlation. This paper points out that respirometry has found use as an excellent indicator of the biological activity of wastewater treatment. Its use by many has stimulated new applications which will enhance its value as a significant analytical tool. (See also W88-00963) (Lantz-PTT)
W88-01051

GEOTHERMAL WASTEWATER TREATMENT AND DISPOSAL,
Collins and Ryder Consulting Engineers, Larkspur, CA.
R. A. Ryder, and R. C. Casias.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 875-891, 7 fig, 8 tab, 12 ref.

Descriptors: *Water pollution prevention, *Wastewater treatment, *Waste disposal, *Geothermal resources, Resources development, Water pollution control, Geothermal power, Air pollution, Water quality control.

The development of geothermal heat sources for the production of energy is a rapidly increasing activity in the Western United States that parallels worldwide interest. Major geothermal developments are occurring in usually volcanic-fault regions of the Earth where the underlying 1,000 C heated magma is closer to the Earth's crust. Geothermal energy is often seen as an economically viable alternative energy source, particularly where energy produced is purchased at more than 7 cents a kilowatt hour. The heat sources are of several types: (1) vapor dominated - dry steam that occurs at the geysers in Northern California, by far the most extensively developed U.S. geothermal field, and a few other places in the world, including Italy; and (2) water dominated - hot water that occurs much more often and is usually superheated and at high pressure. Several major constraints in the development of geothermal resources have been air and water quality emissions and abatement. The technology of economically managing air and water quality is an emerging field that is addressed. (See also W88-00963) (Lantz-PTT)
W88-01052

PROCEEDINGS OF THE DEGRAY LAKE SYMPOSIUM.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 2H.
W88-01056

LAND USE MONITORING AND ASSESSMENT FOR NONPOINT SOURCES POLLUTION CONTROL,
Vermont Univ., Burlington. School of Natural Resources.
R. B. Hopkins, and J. C. Clausen.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 25-29, 5 fig, 3 tab, 20 ref.

Descriptors: *Land use, *Monitoring, *Water quality control, *Nonpoint pollution sources, *Vermont, Water pollution control, Soil environment, Management planning, Water quality management, Agriculture, Phosphorus, Agricultural runoff, Runoff.

Varying soil characteristics, land use patterns, the relative timing of agricultural practices, and hydrologic events complicate quantifying relationship between agricultural land use and surface water quality. In two Vermont watersheds where the effects of best management practice (BMP) implementation on water quality are continuously monitored, land use and agricultural activities are being monitored on a field-by-field level. The land use data are entered in a computerized Geographic Information System (GIS), and the results mapped. Correlation and stepwise regression techniques related weekly land use activities for one subwatershed to surface water quality. Comparisons of water quality to agricultural land use were based on proximity to surface drainage and whether activities had occurred on runoff-producing zones. Manure application on Soil Hydrologic Group D was significantly related to stream total phosphorus concentration ($r = 0.62$) when manure was accumulated between runoff events. A predictive equation developed explained 55% of the variation in total phosphorus concentration. GIS offers the potential to inventory critical sources of nonpoint source pollution and identify changes in water quality from agricultural land use and BMP's. (See also W88-01083) (Author's abstract)
W88-01085

APPROPRIATE DESIGNS FOR DOCUMENTING WATER QUALITY IMPROVEMENTS FROM AGRICULTURAL NPS CONTROL PROGRAMS,
National Water Quality Evaluation Project.
For primary bibliographic entry see Field 7A.
W88-01086

MONITORING FOR WATER QUALITY OBJECTIVES IN RESPONSE TO NONPOINT SOURCE POLLUTION,
Environmental Protection Service, Regina (Saskatchewan). Water Quality Branch.
For primary bibliographic entry see Field 7A.
W88-01087

OVERVIEW OF THE NATIONAL NONPOINT SOURCE POLICY,
Synectics Group, Inc., Washington, DC.
For primary bibliographic entry see Field 6E.
W88-01089

INTERGOVERNMENTAL COORDINATION: FEAST OR FAMINE,
South Brevard Water Authority, Melbourne, FL.
For primary bibliographic entry see Field 6E.
W88-01090

BASIC LEGAL ISSUES,
Environmental Defense Fund, New York.
For primary bibliographic entry see Field 6E.
W88-01091

COMPELLING ON-THE-GROUND IMPLEMENTATION OF MEASURES TO CONTROL NONPOINT SOURCE POLLUTION,
National Audubon Society, Washington, DC.
H. M. Babcock.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 60-61, 1 ref.

Descriptors: *Nonpoint pollution sources, *Water quality control, *Regulations, Public policy, Education, Costs, Water pollution control, Nitrogen, Agriculture, Water quality management.

Experience to date with implementation of measures to control nonpoint source pollution has been largely voluntary, dependent for success on education and subsidization of the costs of erosion control. The record is clear that these measures have not worked - nonpoint pollution is getting worse, not better. A dramatic change in attitudes about how to control nonpoint pollution must be made if this serious source of water quality degradation is to be brought under control. Any program to compel implementation of best management practices must acknowledge the differences between types of sources of nonpoint pollution and the features that distinguish nonpoint pollution from point source pollution (e.g., the inherent problems associated with measuring the amount of pollution caused by that source). What is an appropriate incentive to achieve one source's compliance may not be appropriate for another. A mix of measures, ranging from traditional enforcement tools like citizen suits, cross compliance penalties, permits, and fines to financial incentive like taxes, subsidies, and rewards should be examined for their suitability to different sources of nonpoint pollution nd to the particular conditions of a given watershed. The exact mix of measures should be determined at the State level in an EPA-approved nonpoint program. In applying these measures, off-farm contributors to the chain of nonpoint pollution should not be immune - for example, if excessive nitrogen is a water quality problem associated with nonpoint source pollution, then fertilizer manufacturers should be brought within the regulatory program. The final program must be equitable, effective, and easy to administer. (See also W88-01083) (Author's abstract)
W88-01092

CONTROLLING NONPOINT SOURCES OF POLLUTION - THE FEDERAL LEGAL FRAMEWORK AND THE ALTERNATIVE OF NONFEDERAL ACTION,
Department of the Interior, Washington, DC.
R. R. Greenfield.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 63-67.

Descriptors: *Nonpoint pollution sources, *Water quality control, *Legislation, *Legal aspects, State jurisdiction, Federal jurisdiction, Water pollution control.

State and Federal legal aspects of nonpoint source pollution including a general overview of Federal and representative State laws on the subject are reviewed. A major emphasis is the benefits from reinforcing existing State legal and administrative institutions to serve as the foundation for a national nonpoint source pollution control effort. All too often, when a national regulatory effort is envisioned, individual State differences and preferences are ignored in the effort to articulate a single Federal policy. States can in fact develop and implement meaningful nonpoint source pollution control programs without traditional Federal controls. Even where such pollution involves more than one State and control efforts must be expanded accordingly, there is the potential to use such proven non-Federal dispute resolution tools as interstate compacts or interstate agreements. This paper also considers the adequacy of current Federal nonpoint source control efforts in the context of existing legislative authorities. (See also W88-01083) (Author's abstract)
W88-01093

FUNDING NONPOINT CONTROL PROJECTS IN MISSOURI,
Missouri Dept. of Natural Resources, Jefferson City.
J. Howland.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 69-70.

Descriptors: *Missouri, *Water quality control, *Nonpoint pollution sources, *Project funding, Costs, Legislation, Taxes, Economic aspects, Cost sharing, Soil conservation.

On June 15, 1983, the Missouri General Assembly approved House Joint Resolution No. 21. This measure, called Constitutional Amendment No. 2, was passed by public vote in the November 1984 general election. This amendment increased the State sales tax by 0.1%. Taxation begins July 1, 1985, and will be in effect for five years. The sales tax will generate approximately $30.5 million annually, to be divided equally between State parks and historic sites, and soil conservation. Missouri's Constitutional Amendment No. 2 is a partial answer to solving the problem with funding nonpoint controls related to soil conservation. The Soil and Water Districts Commission proposed to use 77% of its $15 million annual share for direct financial assistance to landowners; 19.7% for technical planning and clerical expenses at the county level; and 3.3% for program administration and State office personnel. This paper describes how the soil protection revenues are to be used. (See also W88-01083) (Lantz-PTT)
W88-01094

STATE OF MARYLAND NONPOINT SOURCE CONTROL IMPLEMENTATION PROGRAM,
Maryland Dept. of Health and Mental Hygiene, Baltimore. Office of Environmental Programs.
K. E. McElroy, and M. C. Halka.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 71-75.

Descriptors: *Maryland, *Water law, *Legal aspects, *Regulation, *Nonpoint pollution sources, *Water quality control, *Chesapeake Bay, Water quality management, Federal jurisdiction, State jurisdiction, Sediment control, Runoff, Storm water, Agricultural runoff, Erosion control, Drainage, Conservation, Mining, Wetlands, Dredging.

The State of Maryland has had a number of nonpoint source control implementation programs dating back to the late 60's and early 70's. Beginning in 1982, the research findings of the Chesapeake Bay Program added momentum. In January 1984, the General Assembly added a great many new programs and modified some existing programs. Not all these programs are outgrowths of the Chesapeake Bay emphasis. Many of them preceded that event. Each program has a different political and institutional situation from which it has been derived. These 12 different programs (sediment control, stormwater control, agricultural runoff control, agricultural drainage control, shoreline erosion control, critical areas commission, retention of existing forestland, conservation easements, dredge and fill projects, nontidal wetlands, mining (noncoal), failing septic systems, and coal mining) will indicate the variety of political situations in which support can be built for new programs. This paper covers each program, how it came into being, how it is institutionally implemented, what the responsibilities at the Federal or State or local level area, how it is financed, and what the State of Maryland has done to date in implementing the program. (See also W88-01083) (Author's abstract)
W88-01095

WISCONSIN NONPOINT SOURCE PROGRAM,
Wisconsin Dept. of Natural Resources, Madison.
J. G. Konrad.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 76-78.

Descriptors: *Wisconsin, *Nonpoint pollution sources, *Water quality control, *Legislation, Public policy, Water pollution control, Water quality management, Agriculture, Regulations.

Nonpoint sources are land areas where activities, including land management, result in the transport of pollutants or contaminants, generally by runoff water, to lakes, streams, or groundwater. The concentrations and volumes vary greatly by season and year; therefore, nonpoint sources are usually more difficult to identify, and produce chronic degradation of water quality. In the Upper Mid-

west, nonpoint source pollutants from both croplands and livestock operations have degraded many surface water resources. Since major portions of Wisconsin are in this critical area, officials recognized years ago that fishable and swimmable water quality will not be reached in many lakes and streams unless an aggressive program for controlling urban and rural nonpoint sources is pursued. The Wisconsin legislature recognized this need and responded in 1978 by creating and funding the Wisconsin Nonpoint Source Water Pollution Abatement Program. The program was tailored to the nonpoint source needs in urban and rural areas of Wisconsin by incorporating aspects of various existing programs as well as devising new approaches. Although participation by landowners and operators is voluntary in this State funded program, substantial pollutant load reductions have been achieved in Priority Watershed Projects. However, no voluntary program will achieve the desired levels of control in all situations. In those cases, regulatory mechanisms must be considered. The elements of the Wisconsin program are designed to effectively and efficiently achieve water quality objectives impaired by nonpoint source pollutants. These program elements, along with the experiences gained during the past 6 years, have resulted in a program structure that is well defined and adaptable to changing needs. Different areas have different needs and existing institutional structures. However, the principles used as the foundation for the Wisconsin nonpoint source control program can be applied to developing effective programs to control a variety of nonpoint source problems in any State. (See also W88-01083) (Lantz-PTT)
W88-01096

BRIDGING THE GAP BETWEEN WATER QUALITY AND NONPOINT SOURCE ACTIVITIES: A CONTINUUM OF INSTITUTIONAL ARRANGEMENTS,
Environmental Protection Agency, Boston, MA.
For primary bibliographic entry see Field 6E.
W88-01097

DEVELOPING NONPOINT SOURCE CONTROL STRATEGIES FOR BIG STONE LAKE: TWO APPROACHES,
Minnesota Pollution Control Agency, Roseville.
G. F. Reetz, T. Bjork, P. J. Mulloy, D. R. German, and S. A. Heiskary.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 88-92.

Descriptors: *Big Stone Lake, *South Dakota, *Minnesota, *Water quality control, *Nonpoint pollution sources, *Water quality management, Eutrophic lakes, Water quality, Agriculture, Interagency cooperation, Computer models, Water pollution control.

Big Stone Lake, a hypereutrophic lake located on the Minnesota-South Dakota border, suffers from algae blooms, excessive weed growth, and sedimentation. The South Dakota Department of Water and Natural Resources, with support from the Minnesota Pollution Control Agency, completed a Diagnostic-Feasibility Study that identified nonpoint source pollution from agricultural land use practices in the lake's 2,983 sq km watershed as the major source of pollution to the lake. Institutional barriers often present a greater task for nonpoint source projects than the technical factors involved in addressing nonpoint source problems. The Big Stone Lake Project provides an interesting case study because its initiation involved and required the cooperation of two regional EPA offices, two States, five counties, and a multitude of State and local agencies. The large size of Big Stone Lake's watershed has also required innovative approaches to identifying and prioritizing nonpoint source pollution strategies. A computer model will be used to target nonpoint source control projects within subwatersheds. (See also W88-01083) (Author's abstract)
W88-01099

NONPOINT SOURCE POLLUTION OF RESERVOIRS: WHAT THE TENNESSEE VALLEY AUTHORITY IS DOING ABOUT IT,
Tennessee Valley Authority, Chattanooga.
L. R. Clark.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 93-95.

Descriptors: *Water quality control, *Nonpoint pollution sources, *Tennessee Valley Authority, Reservoirs, Model studies, Soil erosion, Erosion control, Soil conservation, Interagency cooperation, Water quality management, Agriculture, Legislation.

The Tennessee Valley Authority has constructed a multipurpose reservoir system that is recognized throughout the world as a model for water resources management on a watershed basis. As early as the 1930's TVA recognized the importance of controlling soil erosion to prevent the premature filling of reservoirs and began working with Valley farmers in implementing soil conservation practices. In the 1980's indications of declining water quality in TVA reservoirs prompted a renewed emphasis on reducing nonpoint source pollution and relies heavily on Valley States and other Federal agencies to assist in implementing corrective measures in cooperation with private landowners. TVA uses a variety of techniques to reduce nonpoint sources, such as: (1) identification of nonpoint sources problem areas, (2) serving in a facilitator role to resolve nonpoint source pollution problems, and (3) conducting demonstrations of solutions to nonpoint source problems. (See also W88-01083) (Author's abstract)
W88-01100

COMPREHENSIVE PROTECTION FOR TWO MULTIPURPOSE RESERVOIRS IN CENTRAL NORTH CAROLINA - EPA'S NATIONAL NONPOINT SOURCE POLICY CAN WORK,
Triangle J Council of Governments, Research Triangle Park, NC.
E. A. Holland, and A. W. Klimek.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 96-99, 2 fig, 2 tab.

Descriptors: *Reservoirs, *Water quality control, *North Carolina, *Nonpoint pollution sources, *Regulations, *Neuse Reservoir, Interagency cooperation, B. Everett Jordan Lake, Water supply, Urban planning, Phosphorus, Phosphates, Agriculture, Costs, Funding.

Federal, State, and local agencies are carrying out an aggressive watershed protection program to prevent degradation of two new multipurpose reservoirs in the Raleigh-Durham-Chapel Hill area of North Carolina. The U.S. Army Corps of Engineers impounded the B. Everett Jordan Lake and Falls of the Neuse Reservoirs in 1981 and 1983 for flood control, recreation, and water supply. With a drainage area of almost 6,500 sq km, the reservoirs have a combined surface area of 10,000 ha, and represent a potential raw water source of 200 million gallons/day. An interagency strategy was developed in response to growing public demands for water supply protection amid accelerating urban development and evidence of excessive nutrients in the reservoirs. The strategy is preventive in focus - none of the intended uses has yet been impaired. Phosphorus removal will be required from all new wastewater discharges and from selected existing facilities in the watersheds. The North Carolina General Assembly will consider a statewide ban on the sale of phosphate-containing laundry detergents during its 1985 session. Cities and counties have enacted land use controls and a $2 million a year State-funded cost-share program is helping farmers finance much-needed agricultural BMP's in critical portions of the watersheds. Initial success of the overall strategy appears to support the principles of EPA's proposed National Nonpoint Source Policy. (See also W88-01083) (Author's abstract)
W88-01101

INTERDISCIPLINARY APPROACH TO SHALLOW GROUND WATER CONTAMINATION IN NORTH-CENTRAL MONTANA,
Triangle Conservation District, Conrad, MT.
J. M. Holzer, J. D. Farkell, B. J. Harrison, and G. A. Hockett.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 115-120, 3 fig, 3 tab, 13 ref.

Descriptors: *Groundwater pollution, *Montana, *Groundwater management, *Water pollution control, *Path of pollutants, Agricultural runoff, Saline seep, Salts, Acid mine drainage.

Shallow groundwater quality over portions of the northern Great Plains has degraded considerably over the past 20 to 40 years. Shallow wells in the affected areas have shown a range in total dissolved solids (TDS) from 20,000 to 50,000 mg/L. Although the prevalent geologic and climatic conditions are significant, the degradation is attributed to, for the most part, the cultural farming practices of the region. The use of a strict, alternate crop-fallow management practice results in the inefficient use of annual precipitation and allows for the downward migration of subsurface salts into groundwater systems. In addition, under the right geologic conditions, the salts may resurface and destroy productive cropland in the form of saline seep. It has been estimated that 113,300 ha (280,000 acres) of cropland have been lost to this process in Montana. In north-central Montana, a group of local landowners, in cooperation with State and Federal officials, have formed a technical team to address the problem of saline seep and the degradation of shallow groundwater quality. This team has developed an intensive management plan that reclaims salinized cropland and prevents further degradation of groundwater quality. This has significantly decreased the size of saline seeps in as little as 3 to 5 years. In addition, the knowledge gained has led to potential use of vegetative management as a reclamation tool for other water quality problems such as acid mine drainage. (See also W88-01083) (Author's abstract)
W88-01104

NONPOINT SOURCE IMPACTS ON GROUND WATER QUALITY IN MAJOR LAND RESOURCE AREAS OF THE SOUTHWEST,
Agricultural Research Service, Durant, OK.
For primary bibliographic entry see Field 5G.
W88-01105

NONPOINT SOURCE IMPACTS ON GROUND WATER QUALITY IN MAJOR LAND RESOURCE AREAS OF THE SOUTHWEST,
Agricultural Research Service, Durant, OK.
S. J. Smith, J. W. Naney, and W. A. Berg.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 121-124, 2 fig, 4 tab, 14 ref.

Descriptors: *Groundwater quality, *Nonpoint pollution sources, *Water pollution effects, *Groundwater pollution, *Oklahoma, *Texas, Agricultural runoff, Watersheds, Agriculture, Nitrogen, Phosphorus, Sulfates, Chlorides, Water pollution control.

For the past several years,the impact of agricultural management practices on groundwater quality of watersheds in various land resources areas of Oklahoma and Texas has been assessed. Typically, the watersheds (1.6-6 ha) encompass a wide range of soils and managements. Treatments include different crop, grass, tillage, fertilizer, pesticide, and grazing practices. Results of water quality analyses are presented for 34 groundwater wells of shallow depth (<20 m water table) that are monitored seasonally on the watersheds. Topics considered include the impacts of soluble nitrogen and phosphorus, irrigation suitability, sulfate and chloride, salinity, pesticides, and oil/gas development. Results are related to agricultural management practices, existing geology, and where applicable, past and present petroleum production. In some loca-

tions, local geology and intense early date oilfield activity are reflected in high levels of sulfate and chloride, respectively. However, with few exceptions, farming and ranching activities were found to have limited impact on groundwater quality. (See also W88-01083) (Author's abstract)
W88-01105

MONITORING THE EFFECTS TO THE GROUND WATER SYSTEM ATTRIBUTABLE TO AGRICULTURAL PRACTICES,
South Dakota Dept. of Water and Natural Resources, Pierre.
For primary bibliographic entry see Field 7A.
W88-01106

URBAN NONPOINT SOURCE IMPACTS ON A SURFACE WATER SUPPLY,
For primary bibliographic entry see Field 5C.
W88-01107

NONPOINT SOURCE POLLUTION CONTROL FUNDING FOR LAKE RESTORATION: A CASE STUDY AT CARLISLE LAKE,
Washington State Univ., Pullman. Environmental Engineering Dept.
B. C. Moore, W. H. Funk, and R. Bainbridge.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 138-141, 4 fig, 2 tab, 4 ref.

Descriptors: *Nonpoint pollution sources, *Lake restoration, *Carlisle Lake, *Water pollution control, *Case studies, *Funding, *Water quality control, Washington, Nutrients.

The results of a year-long monitoring program at Carlisle Lake, a small hypereutrophic lake located in southwestern Washington State is presented. The objectives of the study were to assess the current limnology of the lake, to determine and quantify the nutrient sources to the lake, and to make recommendations for possible restoration of the lake and for nutrient control in the watershed. The monitoring has indicated that nonpoint sources associated with dairy and cattle operations contribute most of the external nutrient load to the lake. Sponsored by the Washington State Department of Ecology and conducted by the Washington State University Environmental Engineering Department and the USDA Soil Conservation Service, the study of Carlisle Lake illustrates how an interdisciplinary approach may bring together the expertise to deal with nonpoint source pollution problems. Some of the control measures that may be employed in reducing the loading to Carlisle Lake and some nontraditional funding sources and alternatives for these control measures are discussed. (See also W88-01083) (Author's abstract)
W88-01108

TROPHIC STATE RESPONSE TO NONPOINT POLLUTION CONTROL: APPLICATION OF COUPLED MICROCOMPUTER MODELS TO THE GREAT LAKES,
Michigan Technological Univ., Houghton. Dept. of Civil Engineering.
M. T. Auer, T. M. Heidtke, and R. P. Canale.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 147-152, 5 fig, 2 tab, 22 ref.

Descriptors: *Water quality control, *Nonpoint pollution sources, *Trophic level, *Great Lakes, *Computer models, Water pollution control, Phosphorus, Fox River, Wisconsin, Green Bay, Pollutant load, Chlorophyll, Microcomputers.

Phosphorus loading from the Fox River (Wisconsin) produces a gradient in trophic state along with the major axis of Green Bay (Lake Michigan) ranging from hypereutrophic to oligotrophic. Water quality problems associated with the gradient include high turbidity, excessive algal growth, and dissolved oxygen depletion. The Fox River contributes 78% of the tributary total phosphorus load to Green Bay; more than half of that load originates from nonpoint sources. A unit area load (UAL) based microcomputer model is used to generate estimates of nonpoint total phosphorus loads as a function of land use and soil texture in the Fox River watershed. Phosphorus loads are input to a water quality microcomputer model which calculates the total phosphorus and chlorophyll concentrations, water transparency, and trophic state corresponding to that load. Changes in water quality and trophic hypothetical land use scenarios: 100% woodland and 100% high tillage cropland. The basin is well suited to such a demonstration because of the dominance of the cropland land use classification (65% of total basin land acreage). Water quality and trophic state changes associated with the two hypothetical scenarios are dramatic, demonstrating the utility of the approach in providing a basinwide overview of the potential impact of nonpoint management programs in the watershed. (See also W88-01083) (Author's abstract)
W88-01110

PROJECT TO MANAGE AGRICULTURE WASTES HAS IMPROVED THE QUALITY OF VERMONT'S LAKE PARKER,
Soil Conservation Service, Winooski, VT.
R. J. Croft.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 153-157, 1 fig, 5 tab, 15 ref.

Descriptors: *Agricultural wastes, *Nonpoint pollution sources, *Water quality control, *Vermont, *Lake Parker, *Water pollution control, Fishing, Phosphorus, Bacteria, Dairy industry, Farm wastes, Lakes.

Lake Parker's quality declined in the 1970's. This 83 ha (206 acre), northeastern Vermont Lake suffered from weeds, algae, and bacteria growths. Trout fishing and recreation were no longer an attraction. The Vermont Department of Water Resources determined that the lake's problems were caused by excessive phosphorus and bacteria loads from the 11 dairy farms in the watershed. The town of Glover and other sponsors joined with the Soil Conservation Service to implement a Resource Conservation and Development Project. Eight of the 11 farms had critical waste management problems. All eight participated in the project. Treatment included proper utilization and disposal of wastes through manure storage, barnyard runoff control, and milkhouse waste management. The project was started in January 1981 and completed in June 1982. In 1983 and 1984 Lake Parker has improved markedly. (See also W88-01083) (Author's abstract)
W88-01111

CHESAPEAKE BAY NONPOINT SOURCE POLLUTION,
Chesapeake Bay Liaison Office, Annapolis, MD.
For primary bibliographic entry see Field 5B.
W88-01113

NONPOINT SOURCE POLLUTION CONTROL IN SMALL BAYS OF PUGET SOUND,
Washington Dept. of Ecology, Olympia, WA. Shorelands Div.
B. Saunders.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 177-179, 2 ref.

Descriptors: *Nonpoint pollution sources, *Puget Sound, *Estuaries, *Water pollution control, *Regulations, Shellfish, Water pollution sources, Minter Bay, Burley Lagoon, Ordinances, Waste disposal, Management planning.

In the last 4 years, five commercial shellfish growing areas in Puget Sound have been closed because of nonpoint bacterial contamination. These have been in rural areas characterized by small acreage, semi-recreational farms, rural residential development, and moderate residential density on the saltwater frontage. With one exception, they are notable for the absence of point discharges, large commercial farming, and urban stormwater discharges. The Department of Ecology conducted a year-long study of the water quality in two of these estuaries - Minter Bay and Burley Lagoon. The data correlated stream segment pollution levels with surrounding land use. Agricultural sources appeared to be the major problem, with failing septic tanks the suspect in some areas. The Department funded the two counties in which the watersheds occur to develop a basin plan for controlling the problem. A consultant developed three ordinances to address animal keeping practices, onsite waste disposal, and erosion control. The issues are complicated by the watershed's overlapping two counties with somewhat different sets of land use ordinances in place. Also, community reaction to the initial proposals has been adverse. The proposals are undergoing community review and may undergo considerable revision. Other efforts are being funded to continue to develop farm management plans on a voluntary basis, pending completion of a basin planning program. (See also W88-01083) (Author's abstract)
W88-01115

SHELLFISH SANITATION IN OREGON: CAN IT BE ACHIEVED THROUGH POLLUTION SOURCE MANAGEMENT,
Oregon State Dept. of Environmental Quality, Portland.
J. E. Jackson.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 180-184, 2 fig, 1 tab.

Descriptors: *Water pollution control, *Shellfish farming, *Oregon, *Nonpoint pollution sources, *Water quality management, *Water pollution sources, Estuaries, Wastewater management.

Historically, shellfish growing areas are closed as man's activity pollutes the waters. As these areas close, businesses and jobs are lost in a local and State economy. Oregon is taking a different tack to maintain the limited growing areas available to private industry. Recently completed fecal waste source management plans in Tillamook Bay demonstrate that safe shellfish harvesting can exist in the same estuary as nonpoint and point source discharges - as long as who, what, and when they discharge is known. An overview is presented describing the process of pollution source identification, management option determinations, and management plan development and implementation. (See also W88-01083) (Author's abstract)
W88-01116

MONITORING CHANGES IN AGRICULTURAL RUNOFF QUALITY IN THE LAPLATTE RIVER WATERSHED, VERMONT,
Vermont Univ., Burlington. School of Natural Resources.
D. W. Meals.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 185-190, 5 fig, 4 tab, 23 ref.

Descriptors: *Monitoring, *Agricultural runoff, *Water quality management, *LaPlatte River, *Vermont, *Water pollution sources, Land disposal, Water quality control, Nitrogen, Suspended solids, Phosphorus.

The LaPlatte River Watershed in northwestern Vermont is the focus of an intensive program of land treatment to control agricultural runoff. Best Management Practices (BMP) for controlling dairy manure and cropland erosion have been implemented by the USDA-SCS on 90% of the priority areas in the watershed. A long-term monitoring program is being conducted to evaluate the effectiveness of BMP application in improving water quality. The monitoring program includes precipitation and stream discharge recording and water sampling for suspended solids, phosphorus, and nitrogen analysis. A concurrent land use monitor-

ing program is collecting information required to couple changes in agricultural practices with changes in stream water quality. The water quality monitoring program is outlined. Application of several statistical trend analysis techniques to 5 years of record from four watersheds is described and some results are discussed. (See also W88-01083) (Author's abstract)
W88-01117

NONPOINT SOURCE POLLUTION IN THE RICE CREEK WATERSHED DISTRICT - THE RESULTS OF 10 YEARS OF WATER QUALITY MONITORING,
Hickok (Eugene A.) and Associates, Inc., Wayzata, MN.
P. R. Willenbring, E. A. Hickok, and W. D. Weidenbacher.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 191-195, 1 fig, 4 tab.

Descriptors: *Nonpoint pollution sources, *Rice Creek, *Water quality control, *Monitoring, Path of pollutants, Fate of pollutants, Water pollution control, Runoff, Kjeldahl nitrogen, Phosphorus, Suspended solids, Chlorides.

A summary of nonpoint source water quality data generated by a monitoring program undertaken by the Rice Creek Watershed District from 1974 to 1984 is presented. The monitoring program focused on establishing the characteristics of the nonpoint source runoff generated from 21 subwatersheds that were delineated within the 472.7 sq km watershed district. For each of the subwatersheds, areal loadings and flow-weighted mean concentrations of total Kjeldahl nitrogen, total phosphorus, orthophosphorus, total suspended solids, and chlorides are presented. Detailed land use and hydrology information for each subwatershed are analyzed along with the water quality information to allow the nonpoint source water quality data to be used to model nonpoint source runoff characteristics of other similar subwatersheds. It was found that (1) The best surface water quality is immediately downstream of lake outlets; (2) Lakes and wetlands have the ability to remove nutrients and solids from water routed through them; and (3) The most concentrated solids and nutrient loadings originate from higher density urban areas. (See also W88-01083) (Lantz-PTT)
W88-01118

PESTICIDE MONITORING IN KANSAS SURFACE WATERS: 1973-1984,
Kansas Dept. of Health and Environment, Topeka. Div. of Environment.
For primary bibliographic entry see Field 5B.
W88-01119

EFFECTS OF INTENSIVE AGRICULTURAL LAND USE ON REGIONAL WATER QUALITY IN NORTHWESTERN OHIO,
Heidelberg Coll., Tiffin, OH. Water Quality Lab.
For primary bibliographic entry see Field 4C.
W88-01120

CONTROLLING WATER POLLUTION FROM NONPOINT SOURCE LIVESTOCK OPERATIONS,
Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
J. M. Sweeten, and S. W. Melvin.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 215-217, 2 tab, 13 ref.

Descriptors: *Water pollution control, *Nonpoint pollution sources, *Livestock, Agricultural runoff, Water quality management, Grasses, Runoff, Nutrients, Solids.

Watersheds containing cattle grazing operations sometimes show increased concentrations in adjacent streams of bacterial indicator organisms, primarily coliforms and streptococcus. Reported effects are erratic and detectable only for short distances downstream. Small feedlots (below 1,000 animal units or beef cattle equivalents) are regarded as nonpoint sources of pollution in most states. The distinction between feeding operations that are point sources and those that are nonpoint sources varies among States, but it is typically based on number of head, animal spacing, proximity to streams, and likelihood of wastewater discharge. Best management plans (BMPs) for nonpoint source water pollution control at small feedlots include: (1) Locating the feeding facility away from a stream or drainage channel; (2) Diverting outside runoff away from the feedlot surface using diversion terraces and roof gutters; (3) Collecting solids carried off the feedlot surface by runoff water - solids should be settled out in channels, debris basins, or grass waterways where they can be removed and disposed of properly on land; (4) Installing a grass filter strip at least twice as large as the feedlot, where a small feeding site is close to a waterbody, to improve runoff quality before it enters the water; (5) Installing a runoff holding pond if the water pollution risk is high and the location of a feedlot prevents the use of a vegetated filter; and (6) Making the best use of nutrients in the manure to improve the soil's physical properties by applying manure to cropland. Instead of producing surplus grain on marginal land with increased potential for erosion and water degradation, cattle operations recycle nutrients back to land to manage the soil better. Cattlemen can use alternative BMP's to increase forage and beef production while preventing nonpoint source water pollution. When good management is practiced, cattle production enhances environmental quality and is an important asset to this Nation's soil and water resources. (See also W88-01083) (Lantz-PTT)
W88-01121

STATUS OF SILVICULTURAL NONPOINT SOURCE PROGRAMS,
National Council for Air and Stream Improvement, Corvallis, OR.
G. G. Ice.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 223-226, 23 ref.

Descriptors: *Silviculture, *Water quality control, *Evaluations, *Nonpoint pollution sources, *Management programs, Monitoring, Water pollution control, State jurisdiction, Forestry.

Since 1979, the National Council of the Paper Industry for Air and Stream Improvement (NCASI) has been monitoring and surveying State silvicultural nonpoint source (NPS) control programs. NCASI has examined methods State agencies use to assess how forest operations may hinder State attainment of water quality goals, types of State nonpoint source control programs (voluntary, regulatory, or quasi-regulatory), approaches being used to implement best management practices (BMP's), problems States face in implementing programs, and the degree of program success (based on assessments by States). The overall status of silvicultural NPS control programs can be described as good. Many States have conducted formal field investigations and have found their programs are working. Other States have made adjustments in response to identified problems to improve the effectiveness of their programs. (See also W88-01083) (Lantz-PTT)
W88-01123

ASSOCIATION OF STATE AND INTERSTATE WATER POLLUTION CONTROL ADMINISTRATORS,
Association of State and Interstate Water Pollution Control Administrators, Washington, DC.
For primary bibliographic entry see Field 6E.
W88-01124

ECONOMICS: NONPOINT SOURCE POLLUTION IMPACTS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6C.
W88-01125

ECONOMICS OF NONPOINT SOURCE POLLUTION CONTROL: LAKE TAHOE, CALIFORNIA/NEVADA,
Tahoe Regional Planning Agency, South Lake Tahoe, CA. Long Range Planning Div.
For primary bibliographic entry see Field 6C.
W88-01126

CONTROLLING AGRICULTURAL RUNOFF: GOVERNMENT'S PERSPECTIVE,
Economic Research Service, Washington, DC.
For primary bibliographic entry see Field 6C.
W88-01127

IDENTIFYING CRITICAL NPS CONTRIBUTING WATERSHED AREAS,
FTN Associates, Little Rock, AR.
For primary bibliographic entry see Field 5B.
W88-01128

WATERSHED WATER QUALITY PROGRAMS: LESSONS LEARNED IN ILLINOIS,
Environmental Protection Agency, Chicago, IL. Region V.
T. Davenport, and J. Lowrey.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 256-258, 1 fig, 2 tab, 6 ref.

Descriptors: *Watersheds, *Water quality management, *Water quality programs, *Water pollution control, *Illinois, *Nonpoint pollution sources, Agricultural runoff, Costs, Funding.

Several nonpoint source control projects - Sec. 108 Great Lakes Demonstration Projects, Clean Lakes Projects, Sec. 314 Agricultural Conservation Program Projects, and Rural Clean Water Projects - have been implemented in watersheds critical for agricultural pollution. Evaluation of these ongoing nonpoint source control projects is necessary for facilitating future NPS programs. In Illinois, two major watershed nonpoint source evaluation projects exist. Recommendations on project selection, development, and implementation are discussed based on evaluation of these projects. Some of these recommendations are: (1) Require documentation of the nature and extent of the water resource impairment. Special physical characteristics that could preclude achieving water quality goals (whether documented or perceived) must be recognized; (2) The type of water quality problem determines critical area delineation; (3) The program must be able to correct the identified water quality problem; (4) The information and education program must precede the technical assistance and cost-sharing components; and (5) The use of interagency coordinating committees at the local, State and Federal levels in RCWP projects has proven to be effective in providing leadership and management for water quality projects. (See also W88-01083) (Lantz-PTT)
W88-01130

PRAIRIE ROSE LAKE RURAL CLEAN WATER PROGRAM PROJECT,
Iowa Dept. of Water, Air and Waste Management, Des Moines.
U. Agena, M. Wnuk, and C. M. Lawyer.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 259-263, 3 fig, 4 tab, 5 ref.

Descriptors: *Water quality control, *Water quality programs, *Prairie Rose Lake, *Water pollution control, *Iowa, *Rural areas, Interagency cooperation, Nonpoint pollution sources, Agricultural runoff, Nutrients, Sediments, Monitoring, Lakes, Turbidity, Algae.

Through the cooperative efforts of private landowners and a number of Federal, State, and local agencies, the Prairie Rose Lake (Iowa) Rural Clean Water Program (RCWP) project substantially reduced sediment and nutrient delivery to the lake from its agricultural watershed. Landowner participation has been high, with > 75% of the eligible watershed area included in RCWP contracts. Best management practices installed to date have reduced annual sediment delivery to the lake by 55%, from an estimated 23,670 tonnes (26,300 tons) per year in 1980 to 10,627 tonnes (11,808 tons) per year in 1984. Similar reductions have been projected for phosphorus. Lake water quality monitoring has shown improvements resulting from the project. Water clarity has increased during most seasons of the year, and lake turbidity no longer routinely increases following runoff events. However, algal growths during late summer periods appear to be increasing because of a combination of high in-lake nutrient levels and decreased sediment-related turbidity levels. (See also W88-01083) (Author's abstract)
W88-01131

AGRICULTURAL ISSUES: THE NEBRASKA PERSPECTIVE,
Nebraska Univ.-Lincoln.
R. E. Gold.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 269-272, 5 tab, 7 ref.

Descriptors: *Agricultural runoff, *Nebraska, *Nonpoint pollution sources, *Water pollution control, *Water quality control, Model studies, Nitrates, Nitrogen, Education, Costs, Agriculture.

In the past several years several programs in Nebraska have addressed the problems associated with nonpoint sources of pollution. Two specific programs receiving national attention were the Maple Creek Model Implementation Project and the Hall County Water Quality Special Project. Both projects involved interagency, multidisciplinary approaches to the planning, implementation, and evaluation of best management practices (BMP's) designed to reduce nonpoint pollution. Both projects have been considered a success. Even though the two projects addressed very different problems (soil losses versus nitrate-nitrogen leaching) the successes noted were based on some common principles. Some of these were: (1) Nonpoint pollution problems must be identified and addressed at the local level with planning, implementation, and evaluation based on focused programs rather than areawide or statewide efforts; (2) Education should be emphasized in explaining the advantages (economic and environmental) of BMP's, especially when the projects are based on voluntary participation; (3) Adequate cost-sharing must be provided to offset at least a significant proportion of the real cost of BMP's, particularly if the producers do not realize on-farm monetary benefit; (4) Projects should be planned to last long enough (with adequate funding detailed in advance) to enable results to be quantified and evaluations completed; and (5) A communications network needs to be established between local, State and Federal agencies to ensure overall coordination. The costs associated with the abatement of nonpoint pollution appear to be high, but the benefits can be dramatic and the environmental consequences considerable. (See also W88-01083) (Lantz-PTT)
W88-01133

IRRIGATED AGRICULTURE AND NONPOINT SOURCE POLLUTION IN THE SAN JOAQUIN VALLEY OF CALIFORNIA,
Westlands Water District, Fresno, CA.
For primary bibliographic entry see Field 5B.
W88-01135

BELLEVUE EXPERIENCES WITH URBAN RUNOFF QUALITY CONTROL STRATEGIES,
Bellevue Storm and Surface Water Utility, WA.
P. Bissonnette.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 279-280, 1 ref.

Descriptors: *Urban runoff, *Water quality, *Bellevue, *Washington, *Water pollution effects, *Nonpoint pollution sources, Storm water, Utilities, Economic aspects, Water pollution sources, Erosion, Flooding, Water management, Sedimentation.

The Bellevue Storm and Surface Water (SSW) Utility was formed out of the city's and citizen's commitment to preserve its network of streams and lakes. Established in 1974, the SSW Utility's mission is to manage the storm and surface water system in Bellevue to maintain a hydrologic balance, prevent property damage, and protect water quality for the health, safety, and enjoyment of citizens and for the preservation and enhancement of wildlife habitat. The SSW Utility has five major programs: administration, development regulation, maintenance and operations, water quality control, and capital improvement. The 1985 operating budget is $5.6 million. The 1980-1985 capital improvement budget is $13 million. Bellevue was one of the 27 cities nationwide to participate in the National Urban Runoff Program (NURP). During a 6-yr period, extensive monitoring of urban runoff, its sources of pollutant contamination, and its effects on receiving waters was undertaken. More than 200 storm events and atmospheric and impervious surface pollutant concentrations were monitored. It was found that the beneficial uses of streams that Bellevue seeks to preserve are seriously impaired by urban runoff. The nature of the impairment is largely due to the physical effects of uncontrolled runoff: flooding, erosion, and sedimentation. These effects were large enough to mask most other effects. Were these macroeffects controlled, however, other pollutant effects would become evident, particularly those associated with metals and organic toxicants. It was also found that management practices targeting the street surface and structural drainage system cannot provide a complete solution. An effective control strategy in Bellevue must look beyond the typical public works and utilities design and operations and maintenance practices to source controls, in-stream controls, and even treatment. (See also W88-01083) (Lantz-PTT)
W88-01136

IMPLEMENTING AN URBAN NONPOINT SOURCE CONTROL STRATEGY,
Satterthwaite Associates, Inc., West Chester, PA.
D. F. Lakatos, and A. Cavacas.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 285-288, 2 fig.

Descriptors: *Water pollution control, *Urban runoff, *Nonpoint pollution sources, *Water quality control, *Chesapeake Bay, Water quality management, Standards, Economic aspects, Storm water, Case studies.

The nonpoint 'problem' is often big (for example, the Chesapeake Bay pollution situation) while the specific contributors are small ones (say, a single 50-acre development in the contributing watershed). Therefore, direct links (both technical and economic) are somewhat vague. An implementation strategy developed to meet the needs of the new statewide nonpoint source management program in Maryland had to meet these guidelines: (1) practical to implement, (2) management procedures that would make the least changes possible to existing institutional system, (3) the overall control concept related to economics and, where possible, economic benefits, and (4) the strategy would share objectives, resources, and benefits with ongoing institutional systems. The strategy developed coupled clearly defined steps with ongoing stormwater management and flood control activities. The rise of watershed-level stormwater management programs has allowed for the development of innovative nonpoint source programs that can be easily incorporated within the framework of the comprehensive watershed management plan. The particular aspects of such an incorporation of these two important areas of interest is presented as a case study. (See also W88-01083) (Author's abstract)
W88-01138

URBAN STORMWATER QUALITY MANAGEMENT: THE FLORIDA EXPERIENCE,
Florida State Dept. of Environmental Regulation, Tallahassee.
E. H. Livingston, and J. H. Cox.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 289-291, 1 fig, 1 tab, 2 ref.

Descriptors: *Water quality control, *Water quality management, *Urban runoff, *Storm water, *Florida, *Nonpoint pollution sources, Pollutant load, Water pollution sources, Water pollution control, Regulations, Water management.

Nonpoint sources are responsible for the majority of the pollutant load entering Florida surface and groundwaters. In order to protect and manage the state's invaluable water resources, the Florida Department of Environmental Regulation developed a regulatory program for the control of nonpoint sources, especially urban stormwater. The Stormwater Rule was developed over a two year period with extensive participation by the regulated and environmental communities. The rule established a performance standard for the treatment of stormwater which is based on two properties of stormwater, annual storm frequency distribution and the first flush of pollutants. General permits offer encouragement to applicants to use appropriate best management practices while delegation to the state's regional water management districts coordinates water quality and water quantity considerations into one permit process. (See also W88-01083) (Author's abstract)
W88-01139

PROBLEMS AND PROGRESS IN URBAN SOIL EROSION AND SEDIMENTATION CONTROL: A BICOUNTY PERSPECTIVE,
Lake County Dept. of Planning, Zoning and Environmental Quality, Waukegan, IL.
For primary bibliographic entry see Field 6E.
W88-01140

NATIONAL PERSPECTIVE ON ENVIRONMENTAL CONSTRAINTS TO HYDROELECTRIC DEVELOPMENT,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 6E.
W88-01141

ACID MINE DRAINAGE: SURFACE MINE TREATMENT AND IN-SITU ABATEMENT TECHNOLOGY,
South Carolina Univ., Columbia. Dept. of Geology.
F. T. Caruccio, and G. Geidel.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 307-310, 14 ref.

Descriptors: *Water pollution treatment, *Acid mine drainage, *Wastewater treatment, *Water pollution control, In-situ methods, Neutralization, Detergents, Chemical treatment, Phosphates, Plastic lines, Limestone, Alkalinity.

Many treatment and control measures are available to mitigate and abate acid mine drainage from surface mines, such as: (1) Large-scale neutralization; (2) Small-scale chemical neutralization; (3) Wetlands; (4) Detergents and bactericidal additives; (5) Phosphate complexes; (6) Selective placement of toxic material; (7) Plastic liners; (8) Blanket (surface) application of limestone; and (9) Induced alkaline recharge zones. The technique deemed most appropriate for a particular mine site depends on the age of the mine site, the permeability and character of the mine surface, the degree of

vegetation, the degree of calcareous material present in the overburden, the availability of a chosen ameliorant, accessibility of the site by equipment, and the source (physical and hydrologic) of the acidic seeps in the backfill or mine regime. Those are but a few considerations to be examined in choosing an effective treatment technique. The problem site must be explored by drilling; the hydrogeochemical system must be understood and the acid source identified before the treatment technology is implemented. (See also W88-01083) (Lantz-PTT)
W88-01142

FACTORS AND TREATMENT OF ABANDONED ACID MINE LANDS FOR CONTROLLING NONPOINT SOURCE POLLUTION,
Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.
V. P. Evangelou, and W. O. Thom.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 314-316, 7 tab, 7 ref.

Descriptors: *Water pollution control, *Nonpoint pollution sources, *Acid mine waters, *Water pollution treatment, *Water pollution sources, *Pollutant identification, *Mine wastes, Chemical analysis, Hydrogen ion concentration, Geology, Sandstone, Shale, Siltstone, Classification, Acidity, Salinity.

A spoil is a heterogeneous mass of geologic material composed of sandstone, shale, and siltstone at different stages of physical and chemical weathering. Chemical classification of spoils has always been used as a means of determining potential nonpoint source pollution. In the past, the practice has been to chemically classify spoils according to their pH and acid or neutralization potential. Such a classification commonly misrepresents mine spoil material because it assumes that pH is the main obstacle to reclamation. However, spoils may be further classified, especially acid spoils that have been abandoned for a number of years. It can be said that abandoned acid mine spoils can be divided into four general chemical classifications based on electrical conductivity and pH of the spoil solution. This report shows in some detail: (1) the factors that cause abandoned mine spoils to become acid and saline - gypsiferous; (2) the influences that acidity and salinity have on reclamation; (3) the proper frequency and chemical tests that need to be run to identify a spoil's proper classification; and (4) ways to approach the solution of the abandoned acid mine land reclamation problem. (See also W88-01083) (Lantz-PTT)
W88-01143

IMPLEMENTING THE PUBLIC/PRIVATE NONPOINT SOURCE MANAGEMENT PARTNERSHIP: A STATE FORESTRY PERSPECTIVE,
Oklahoma State Dept. of Agriculture, Oklahoma City. Forestry Div.
R. L. Davis, and R. L. Miller.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 325-329, 25 ref.

Descriptors: *Water pollution control, *Nonpoint pollution sources, *Water quality management, *State jurisdiction, *Forestry, Interagency cooperation, Public policy, Regulations, Economic aspects, Water pollution control, Legal aspects.

State forestry agencies currently recognize two principal areas of concern in nonpoint source water quality management: to work with the private sector to get the management job done in the face of poor economic conditions, and to establish a more effective framework in law and policy for doing so. The new national nonpoint source policy promises to be an important advancement toward these ends, particularly because of its support for a cooperative public/private partnership approach. Opportunities exist for improvements where economic factors are not primarily limiting, particularly in public sector actions. As first priority, the public sector should put its house in order by applying the public/private partnership provisions of the new national nonpoint source policy. Action needs include clear signals, recognition of pertinent technical and social considerations in assessments and performance evaluations, insuring local private sector participation in program development, and recognition of the necessity for developing local management program infrastructure and managerial resources. (See also W88-01083) (Author's abstract)
W88-01144

NONCOAL MINERAL MINING AND RECLAMATION (CURRENT AND ABANDONED OPERATIONS) IN THE TENNESSEE RIVER BASIN,
Tennessee Valley Authority, Norris.
J. A. Muncy.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 340-341, 1 fig.

Descriptors: *Water quality control, *Land reclamation, *Tennessee River, *Mine wastes, Erosion, Regulations, Legislation, Environmental effects, Funding.

Although progress is being made to reclaim erosive abandoned mine lands through cooperative efforts, the circumstances that allow such lands to develop have not totally disappeared. Legislation regulating mining is a step in the right direction, but these regulations must be enforced to minimize the environmental problems of surface mining for resources other than coal. Also, mineral mines not presently covered by State laws should be periodically reevaluated to ensure that their related mining activities do not cause future environmental problems. More funding sources are needed for action programs to deal with the abandoned mine lands that cause offsite environmental degradation. (See also W88-01083) (Lantz-PTT)
W88-01146

MANAGING HEADWATER AREAS FOR CONTROL OF SEDIMENT AND SALT PRODUCTION FROM WESTERN RANGELANDS,
Bureau of Land Management, Lakewood, CO. Denver Service Center.
W. L. Jackson, E. B. Janes, and B. P. Van Haveren.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 347-351, 2 tab, 22 ref.

Descriptors: *Water pollution control, *Water quality management, *Sediment control, *Water quality control, *Utah, *Colorado, *Nonpoint pollution sources, Shales, Salts, Water pollution prevention, Water quality, Case studies, Sheep Creek Resource Conservation area, Lower Missouri Creek Tributaries Stabilization project.

Control of nonpoint source water pollutants poses special challenges on western rangelands. The public rangelands managed by the Bureau of Land Management are often characterized by unstable sedimentary geologic parent material, semiarid climate, and sparse vegetation. Intense summer thunderstorms produce locally heavy runoff. Where marine shales are exposed at the surface, their sediments often contain high concentrations of soluble salts. The immense size of the sediment- and salt-producing areas poses treatment problems, both from a technical and economic standpoint. Treatment objectives include retention of runoff water and stabilization of actively eroding gullies in headwater areas. Watershed improvement projects are designed to provide multiple resource benefits, such as water supplies for livestock and wildlife, improvement of water quality, and retention or enhancement of site primary productivity. Two representative watershed improvement projects are described: Sheep Creek Resource Conservation Area in southern Utah and Lower Missouri Creek Tributaries Stabilization Project in northwestern Colorado. (See also W88-01083) (Author's abstract)
W88-01149

SALINITY: NONPOINT SOURCE PROBLEM IN THE COLORADO RIVER BASIN,
Bureau of Reclamation, Denver, CO. Colorado River Water Quality Office.
For primary bibliographic entry see Field 5B.
W88-01150

CONTINUOUS SALINITY STATION MONITORING IN THE COLORADO RIVER BASIN BY THE UTAH BUREAU OF WATER POLLUTION CONTROL,
Utah Bureau of Water Pollution Control, Salt Lake City.
For primary bibliographic entry see Field 7B.
W88-01151

SALINITY CONTROL IN THE GRAND VALLEY OF COLORADO,
Grand Valley Salinity Program, Grand Junction, CO.
F. R. Riggle, and L. N. Kysar.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 359-361.

Descriptors: *Salinity, *Water quality control, *Grand Valley, *Colorado, *Water pollution control, *Water pollution sources, *Imperial Dam, Salts, Irrigation, Percolation, Colorado River.

Half the salt annually entering the Colorado river system comes from manmade influences, and most comes via irrigation seepage and on-farm percolation. To reduce the concentration of salts entering Imperial Dam by 1 mg/L, nearly 11,000 tons need to be prevented from entering the river. A U.S. Department of Agriculture and Department of Interior program attempted to reduce these loads by 50% through lining and piping the irrigation systems and improving on-farm practices. The project, scheduled to run through the year 2000, is 10-20% complete. Projections indicate salinity in the Imperial Dam should have already decreased by 4.3 mg/L. (See also W88-01083) (Author's abstract)
W88-01152

PRACTICAL GUIDELINES FOR SELECTING CRITICAL AREAS FOR CONTROLLING NONPOINT SOURCE PESTICIDE CONTAMINATION OF AQUATIC SYSTEMS,
North Carolina State Univ., Raleigh.
R. P. Maas, M. D. Smolen, S. A. Dressing, C. A. Jamieson, and J. Spooner.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 363-367, 3 tab, 14 ref.

Descriptors: *Water quality control, *Nonpoint pollution sources, *Water pollution control, *Pesticides, *Guidelines, Water quality management, Classification.

Numerous criteria are appropriate for selecting critical areas for addressing pesticide-related water resource impairments. The most important of these is whether the pesticide causing the impairment is actually used in the area and at what rate. The next most important criterion is the type and severity of the water resource impairment. The relative importance of other source magnitude and transport-related criteria depend on the physical, chemical, or biological properties of the pesticide, particularly whether it is transported in the dissolved or adsorbed phase. A farm-level critical area rating form can be used to rank farm units for pesticide control. Public financial resources for pesticide best management plans should be spent on the basis of the scores received on the rating form for the greatest cost-efficiency. (See also W88-01083) (Lantz-PTT)
W88-01153

METHOD FOR PRIORITIZING WATER QUALITY PROBLEM AREAS,
Agricultural Research Service, Morris, MN.
R. A. Young, C. A. Onstad, D. D. Bosch, and W. P. Anderson.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 368-373, 1 fig, 3 tab, 12 ref.

Descriptors: *Water quality management, *Classification, *Model studies, *Nonpoint pollution sources, *Water pollution control, *Minnesota, *Simulation analysis, Water quality control, Geohydrology, Sediments, Nutrients, Nitrogen, Phosphorus, Chemical oxygen demand.

A computer simulation model to analyze nonpoint source pollution from agricultural watersheds in the State of Minnesota has been developed as a predictive tool to investigate water quality problems of different watersheds. This simulation is based on single storm events defined in terms of frequency and duration and is intended for use on watersheds ranging in size from 500 to 23,000 acres. The model uses geographic cells of data units at a resolution of 40 acres or 10 acres. The model inputs existing (or proposed) land management conditions and simulates the transport of sediment, nutrients, and flow from the headwaters of a watershed to the outlet in a stepwise manner so that an assessment can be made for land parcels in the watershed. The nutrients presently examined by the model are nitrogen, phosphorus, and chemical oxygen demand. A small scale version of the model intended for use on watersheds ranging from 1 to 500 acres has also been developed and tested. This model is designed to run on a handheld programmable calculator (such as the HP 41CV) so that the amount of time needed to assemble and input data and obtain results for a 500-acre watershed does not exceed 3 mandays. (See also W88-01083) (Author's abstract)
W88-01154

USE OF WETLANDS IN TREATING NONPOINT SOURCE POLLUTION,
Hickok (Eugene A.) and Associates, Inc., Wayzata, MN.
P. R. Willenbring, and W. D. Weidenbacher.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 380-381, 2 tab, 4 ref.

Descriptors: *Water quality control, *Nonpoint pollution sources, *Water pollution treatment, *Wetlands, *Water pollution control, Stormwater runoff.

The role that wetlands play in treating stormwater runoff is examined. Physical and chemical mechanisms through which wetlands remove pollutants from nonpoint source runoff are reviewed and specific wetland characteristics that can increase the pollutant removal efficiencies are identified. Watershed factors that affect the quality of the nonpoint source runoff generated from a given watershed and the ability of a given wetland to treat this runoff are outlined. Also presented is a procedure that can be used for planning purposes to quantify the need for preserving a wetland in a given watershed. The need for preserving the wetland is based on the wetland's ability to mitigate adverse impacts to the surface water resources in its watershed. (See also W88-01083) (Author's abstract)
W88-01156

ANTIDESERTIFICATION OF RIPARIAN ZONES AND CONTROL OF NONPOINT SOURCE POLLUTION,
Wyoming Univ., Laramie. Range Management Div.
Q. D. Skinner, J. L. Dodd, J. D. Rodgers, and M. A. Smith.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 382-386, 45 ref.

Descriptors: *Water pollution control, *Nonpoint pollution sources, *Water quality control, *Semiarid lands, *Riparian land, *Wyoming, Animal wastes, Flooding, Grazing, Vegetation regrowth, Flow control, Water management.

Overgrazing by domestic livestock and periodic flooding are often cited as sources for increasing nonpoint source pollution in streams within semiarid rangelands. Riparian zones along streams may help decrease nonpoint pollution if maintained in a healthy ecological condition. Two research programs were designed to reverse desertification of streamside zones along cold desert streams in Wyoming by: (1) manipulating livestock grazing, (2) promoting regrowth of desirable vegetation, (3) willow planting, (4) using instream flow structures to store water in channel banks and trap sediment, and (5) encouraging beaver damming. Research theory as well as monitoring protocol are discussed and related to ease of use by management agencies and producer groups affiliated with western rangelands. (See also W88-01083) (Author's abstract)
W88-01157

ROCK CREEK RURAL CLEAN WATER PROGRAM: THE EXPERIMENT CONTINUES,
Soil Conservation Service, Twin Falls, ID. Rural Clean Water Program.
M. J. Neubeiser.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 391-396, 2 fig, 11 ref.

Descriptors: *Water pollution control, *Nonpoint pollution sources, *Water quality control, *Rock Creek, *Idaho, Rural areas, Water quality management, Sediment load, Irrigation practices, Erosion.

The Rock Creek Rural Clean Water Program (RCWP) has significantly reduced sediment loading into Rock Creek using a combination of sediment retention and irrigation improvement practices, including irrigation water management. Participation has been higher than expected because of a successful information and education effort, cost-sharing, and the positive results of best management plans (BMP's) already used that stimulated further landowner interest. The project has approximately 11,400 ha (28,159 acres) identified as critically eroding or highly subject to erosion. The goal is to treat 75% or 8,550 ha (21,119 acres), through a combination of BMP's carried out under long-term contracts. As of September 1984, 146 contracts planned to treat 7,092 ha (17,517 acres) were in effect, approximately 83% of the contracting goal. After only 4 years the Rock Creek RCWP has significantly helped meet targeted chemical parameters. As BMP implementation expands to influence and benefit more acres in the project area, the resultant reduced pollutant loads discharged from the subbasins should become even more pronounced. (See also W88-01083) (Lantz-PTT)
W88-01159

REGULATING NONPOINT SOURCES OF POLLUTION FROM TIMBER HARVESTING - A CASE HISTORY OF THE CALIFORNIA EXPERIENCE,
Humboldt State Univ., Arcata, CA.
C. S. Yee.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 397-401, 2 fig, 1 tab, 2 ref.

Descriptors: *Water pollution control, *Water quality control, *Nonpoint pollution sources, *California, *Case studies, *Forestry, Legislation, Regulations, History.

California possesses 16,800,000 ha of forest land, making it one of America's top timber producing States. To meet the mandate of the 1972 Federal Water Pollution Control Act, section 208, the State of California has had to initiate significant institutional and regulatory changes to comply with this legislation. Regulation of forest practices in California on private timber harvesting permits prepared by State-licensed professional foresters, interdisciplinary review and approval of timber harvesting plans by the State's Department of Forestry, and ongoing enforcement inspections during the operational life of the plan. In addition, logging operators in the State must also be licensed, adding additional leverage for rule compliance during logging. Summarized is the history of the last 8 years involving the California State Board of Forestry efforts to institute a silvicultural nonpoint source pollution control program. (See also W88-01083) (Author's abstract)
W88-01160

AGRICULTURAL NONPOINT SOURCE STUDIES IN SOUTHEASTERN WATERSHEDS: FIELD MONITORING AND FARMER SURVEYS,
North Carolina State Univ. at Raleigh.
For primary bibliographic entry see Field 5B.
W88-01161

VERMONT'S LAPLATTE RIVER WATERSHED PROJECT: LESSONS LEARNED,
Soil Conservation Service, Wincoski, VT.
J. D. Mahood.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 408-411, 3 fig, 1 tab, 12 ref.

Descriptors: *Water pollution control, *Vermont, *LaPlatte River, *Water quality management, *Nonpoint pollution sources, Water quality control, Watersheds, Model studies, Water quality, Monitoring.

In 1979, the LaPlatte River Watershed became the first land treatment only P.L. 83-566 project. The purpose of the project was to reduce the runoff of agricultural nonpoint sources pollutants into Shelburne Bay of Lake Champlain. Being the first project of its kind, there were few established guidelines to follow for either planning or implementation. As the program evolved, its strengths and weaknesses have become more obvious. These lessons resulted in improvements for the ongoing project as well as for new projects. The LaPlatte River Watershed program is described. Both the watershed treatment project and the water quality monitoring and analysis program are discussed. Recommendations for the planning, implementing, and monitoring of similar programs are presented. (See also W88-01083) (Author's abstract)
W88-01162

POINT/NONPOINT SOURCE TRADING PROGRAM FOR DILLON RESERVOIR AND PLANNED EXTENSIONS FOR OTHER AREAS,
Northwest Colorado Council of Governments, Frisco.
T. Elmore, J. Jakasch, and D. Downing.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 413-416, 2 tab, 8 ref.

Descriptors: *Water pollution prevention, *Nonpoint pollution sources, *Dillon Reservoir, *Colorado, *Water quality management, *Regulations, *Project evaluations, Water quality control, National Pollution Discharge Permit Systems, Permits, Runoff.

Nonpoint sources play a major role in water quality programs. Virtually all States have some water quality problems because of nonpoint sources, and half those States say nonpoint sources are the major or significant cause of degraded water quality. Nonpoint sources are the largest remaining uncontrolled pollution problem. Controlling nonpoint source pollution from forestry, agriculture, mining, and urban runoff has been studied extensively. One innovative approach to encourage nonpoint source control is to tie nonpoint sources into the existing National Pollution Discharge Permit System (NPDES). This is a feature of a new program in Colorado that will clean up runoff and

save local governments millions of dollars annually. The Dillon Reservoir Trading Project in Summit County grants wastewater treatment plants credit for cleaning up runoff (nonpoint source) pollution. The pollution trading program is the first of its type in the Nation. This Dillon Reservoir Trading Program is described in detail, ongoing analyses related to the Dillon concept, are discussed, and Dillon's implications for other regions of the country are evaluated. (See also W88-01083) (Lantz-PTT)
W88-01163

OPTIMIZING POINT/NONPOINT SOURCE TRADEOFF IN THE HOLSTON RIVER NEAR KINGSPORT, TENNESSEE,
Environmental Protection Agency, Washington, DC.
M. K. Podar, J. A. Jaksch, S. L. Sessions, J. C. Crossman, and R. J. Ruane.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 417-424, 7 fig, 4 tab, 3 ref.

Descriptors: *Water quality control, *Holston River, *Kingsport, *Water pollution control, *Tennessee, *Nonpoint pollution sources, *Economic aspects, Biological oxygen demand, Dissolved oxygen, Cost analysis, Water quality management, Costs.

The Office of Policy, Planning, and Evaluation of the U.S. Environmental Protection Agency is studying a variety of innovative approaches for controlling water pollution from point and nonpoint sources. Among them is the trading of effluent loads of water pollutants. This approach differs from current EPA water policy in that the State or regional authority responsible for issuing discharge permits for pollutants under the Clean Water Act may modify those limits if two or more dischargers propose a reallocation, or a trade. The reallocation allows dischargers with lower treatment costs to control more pollution and those with higher costs to control less. Thus, the dischargers comply with the same total load limit and achieve in-stream water quality standards at a total lower cost. EPA's Office of Policy, Planning and Evaluation and the Tennessee Valley Authority's Office of Natural Resources and Economic Development initiated this study of trading among point and nonpoint sources of pollution along a 32-km (20-mile) reach of the Holston River. Dissolved oxygen (DO) was selected as the variable of interest and several means to enhance DO in the river were examined: further restrictions of the discharges of oxygen-demanding wastes (for example, five day BOD, varying flow regimes, injecting air into the stream, and trading between point and nonpoint sources.) With these various treatments available, the study evolved into a question of cost-effectiveness: for a given stretch of waterway with specified upstream and downstream boundaries, what mix of point and nonpoint sources and sinks of oxygen will achieve desired DO concentrations at key times and places at the lowest total annual (incremental) cost. (See also W88-01083) (Lantz-PTT)
W88-01164

PROTECTING TILLAMOOK BAY SHELLFISH WITH POINT/NONPOINT SOURCE CONTROLS,
Oregon State Dept. of Environmental Quality, Portland.
J. E. Jackson.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 425.

Descriptors: *Water quality management, *Water quality control, *Tillamook Bay, *Shellfish, *Oregon, *Nonpoint pollution sources, *Water pollution prevention, Feces, Wastewater disposal, Agricultural wastes, Agricultural runoff, Cleanup operations, Diary industry.

Tillamook Bay, located on the North Oregon Coast 96 km west of Portland, is Oregon's second largest estuary but produces the State's largest amount of commercially grown oysters. Because of its close proximity to the metropolitan area of Portland, it is also a popular recreational area for clam diggers, fishermen, swimmers, and sightseers. In 1979, the bay waters and many of the streams draining into the bay were found to be contaminated by fecal material from, at that time, sources unknown. The water quality conditions threatened closure of the Bay to the shellfish harvesting that supported a portion of the local economy of approximately 13,000 people. Under U.S. EPA Section 208 funds the Oregon Department of Environmental Quality conducted a project from July 1979 to June 1981. The project identified malfunctioning sewage treatment plants, some malfunctioning or inadequate on-site subsurface sewage disposal systems, and some agricultural operations discharging fecal material to the streams and bay that created a health hazard for consumption of bay shellfish and endangered swimmers in the tributaries. To institute the cleanup of the pollution problems, the who, when, and where factors of the dischargers had to be known. Placement of the cleanup emphasis became a major tradeoff decision with the cleanup goal firmly in mind. The water quality is improving basinwide from cleanup activities dealing with dairy wastes and on-site subsurface sewage problems in localized areas. The infrequent sewage treatment plant malfunctions have been monitored when they occur. (See also W88-01083) (Lantz-PTT)
W88-01165

POINT/NONPOINT SOURCE INTERFACE ISSUES IN WISCONSIN,
Wisconsin Dept. of Natural Resources, Madison. Bureau of Water Supply.
B. Baker, and S. Skavroneck.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 426-427.

Descriptors: *Nonpoint pollution sources, *Water quality control, *Water pollution control, *Wisconsin, Wastewater disposal, Performance evaluation, Management planning, Water quality standards, Water quality management.

Two types of point/nonpoint source issues have become apparent in Wisconsin. The first type occurs when wastewater treatment plants are upgraded to maintain water quality standards in the receiving stream, yet when the new plant goes on line the standards and beneficial uses are not achieved because of nonpoint sources. The second type of issue involves the achievement of nonpoint source control objectives in the presence of a point source discharge, typically a large wastewater treatment plant. The key question is whether water quality improvements from a priority watershed project to control nonpoint sources would be negated by water quality degradation by point sources. This has become an important issue in Wisconsin's Nonpoint Source Grant Program. The point/nonpoint source issues are being addressed through several of Wisconsin's Water Resource Management programs including Water Quality Management Plans, Effluent Limit Setting, and the Nonpoint Source Grant Program through Priority Watershed Plans. Regardless of the program, the overall framework for addressing point/nonpoint source issues should be: (1) problem identification; (2) analysis of the relative contribution of point and nonpoint pollution sources to the water quality problem; (3) definition of water quality improvement objectives based on the identified problems; (4) assessment of the ability to meet water quality improvement objectives with various combinations of point and nonpoint source controls, and (5) development of a management plan recommending appropriate point and nonpoint source controls. If necessary, modifications might be made to the previously established water quality improvement objectives to reflect their attainability. (See also W88-01083) (Lantz-PTT)
W88-01166

DATA MANAGEMENT SYSTEM TO EVALUATE WATER QUALITY IMPACTS OF NONPOINT SOURCE POLLUTION CONTROL,
North Carolina State Univ., Raleigh.
M. D. Smolen, S. A. Dressing, R. P. Maas, J. Spooner, and C. A. Jamieson.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 429-432, 2 fig, 1 ref.

Descriptors: *Data processing, *Evaluation, *Water quality control, *Nonpoint pollution sources, *Water pollution control, National Water Quality Evaluation Project, Databases, Data storage and retrieval, Project performance, Land disposal, Water quality.

The data base and data management system of the National Water Quality Evaluation Project (North Carolina State University) were developed specifically to analyze the effects of various approaches to land treatment in the context of diverse hydrologic, geologic, meteorologic, and socioeconomic factors. The data base consists of two parts: (1) an annotated bibliography and (2) a water quality profile file, containing summaries of agricultural water quality projects. The project file contains subfiles for general project data, detailed descriptions of projects' water quality problems and land treatment programs, and, summaries of the projects' water quality results. Land treatment data are indexed by project code, date, and a Land Area Resource Code (LARC), and water resource and water quality data are indexed by project code, date, and a Water Resource Code (WARC). Water quality results are then related to land treatment by associating LARCs with WARCs. The data base is used to evaluate water quality projects, but future developmental effort will be directed toward a best management planning decision matrix to access all available information for making and planning nonpoint source pollution projects. (See also W88-01083) (Author's abstract)
W88-01167

DEVELOPMENT OF A NONPOINT SOURCE DATA CENTER,
Synectics Group, Inc., Washington, DC.
C. M. Gesalman.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 433-436, 3 ref.

Descriptors: *Nonpoint pollution sources, *Water quality, *Data collections, *Data storage and retrieval, Water quality management.

One challenge faced by managers of nonpoint source control programs is tracking progress made in solving problems. Program managers and staff often do not have ready access to the latest information on, for example, best management practices, water quality effects and benefits, and other State programs. Such information is needed for problem assessment, designing solutions, and evaluating progress. The design of a prototype nonpoint source data center is presented. The center is being established based on needs identified through interviews and questionnaires and is based on data from Chesapeake Bay States. The center's information will be available to all States and local governments and to the public, and the database will be gradually expanded to cover all States. Existing data and information centers such as the Conservation Tillage Information Center were evaluated during the study to allow the new nonpoint source data center to build upon their experiences. (See also W88-01083) (Author's abstract)
W88-01168

WATER QUALITY DATA AND URBAN NONPOINT SOURCE POLLUTION: THE NATIONWIDE URBAN RUNOFF PROGRAM,
Environmental Protection Agency, Washington, DC.
D. Niedzialkowski, and D. Athayde.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 437-441, 2 fig, 4 ref.

Descriptors: *Water quality, *Data collections, *Nonpoint pollution sources, *Urban runoff, Water quality management, Water quality control, Urban areas, Management planning.

Prior to 1960, concerns about urban stormwater were related primarily to flooding and drainage problems. More recent studies have focused on characterizing and quantifying pollutants in stormwater or developing methodologies for reducing loads. While such research contributes to understanding urban nonpoint source runoff, it does little to illuminate the cause/effect relationship between stormwater and associated water quality of the receiving water. Water quality planners need information to guide their stormwater management decisions to help them determine: (1) if there is a problem; (2) the significance of the problem; and (3) whether they need to do anything about it. Lack of good data and appropriate methodologies have often been cited as the reason it is difficult to relate stormwater runoff to the water quality of the receiving waters. The Nationwide Urban Runoff Program (NURP) sponsored by EPA is described, which was undertaken to respond to these needs by providing support, data, and methodologies for urban nonpoint source problem assessment and water quality planning. (See also W88-01083) (Author's abstract)
W88-01169

RFF NATIONAL DATA BASE FOR NONPOINT SOURCE POLICY ASSESSMENTS,
Resources for the Future, Inc., Washington, DC.
L. P. Gianessi.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 442-445, 19 ref.

Descriptors: *Data collections, *Nonpoint pollution sources, *Project evaluation, *Water quality management, Databases, Data interpretation, Water quality, Water pollution sources.

A newly developed data base for national quantitative assessments of the nonpoint source water pollution problem uses variety of methods to integrate often disparate sources of information into a unified inventory of nonpoint sources. The type of quantitative information needed to locate and quantify nonpoint source levels includes a wide variety of demographic, hydrologic, meteorologic, engineering, and field measurement data. A variety of benchmark years has been employed in the various sources of data. A variety of benchmark years has been employed in the various sources of data. Lack of data for certain parameters requires the assumption of average values for very large regions. While it is desirable to integrate point and nonpoint sources of water pollution into the same inventory, often this means conversion of nonpoint source data using extremely simplified procedures. The type of information required and actually used for validation of the estimates contained in the RFF data base is discussed. Finally, suggestions are made for priorities in the future collection of data and information to make it possible to improve the accuracy of the estimates. (See also W88-01083) (Author's abstract)
W88-01170

BACTERIAL WATER QUALITY AND SHELLFISH HARVESTING,
Oregon State Dept. of Environmental Quality, Portland.
E. A. Glendening.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 447-454, 2 fig, 3 tab, 13 ref.

Descriptors: *Nonpoint pollution sources, *Water pollution control, *Water quality standards, *Shellfish, *Tillamook Bay, *Oregon, *Fisheries, Fecal coliforms, Water pollution sources, Water quality management.

One effort to enforce water quality standards for the commercial shellfishing industry in Oregon's Tillamook Bay led to a federally sponsored 208 water quality study and then to the development of plans to reduce nonpoint source pollution inputs and to establish criteria under which the bay would be closed to harvesting. First the characteristics of the Tillmook drainage basin are briefly described and the problems and programs that preceded the 208 efforts summarized. The results of the 208 research projects are presented, focusing on how the lack of results showing straightforward correlations between shellfish contaminations and bay pollution levels necessitated further analyses. Total and fecal coliform water quality standards can indicate sources of fecal pollution in fresh and estuarine waters. In the absence of better data, they are often used as indicators of shellfish pollution. However, a relationship exists between densities of coliforms in shellfish-growing waters and the densities of coliforms in shellfish meats. Shellfish management plans should investigate these complex relationships and use them to develop closure criteria for shellfish harvesting based on the probability of high coliform densities in shellfish meats. Further research is needed to establish an indicator directly related to the incidence of disease. To this end, recently proposed EPA bacterial water quality criteria for fresh and marine water contact recreational waters attempt to establish a more direct relationship to the incidence of disease. It is hoped that the FDA will investigate and establish bacterial criteria that are more directly related to the incidence of disease for use in shellfish-growing waters. (See also W88-01083) (Lantz-PTI)
W88-01171

EVALUATION OF NONPOINT SOURCE IMPACTS ON WATER QUALITY FROM FOREST PRACTICES IN IDAHO: RELATION TO WATER QUALITY STANDARDS,
Idaho Div. of Environment, Boise.
For primary bibliographic entry see Field 5C.
W88-01172

ILLINOIS AGRICULTURAL SOIL EROSION CONTROL STANDARDS: A USEFUL TOOL FOR NONPOINT SOURCE POLLUTION CONTROL,
Association of Illinois Soil and Water Conservation Districts, Springfield.
H. Hendrickson, G. Deverman, and J. Pendowski.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 459-463, 4 fig.

Descriptors: *Illinois, *Water pollution control, *Soil erosion, *Erosion control, *Nonpoint pollution sources, *Water quality control, Water quality management, Agriculture, Costs, Water quality.

Illinois' primary nonpoint source pollutant is sediment from agricultural land. The Illinois Water Quality Management plan estimated costs of sediment pollution. The legislature and subsequently all 98 soil and water conservation districts adopted a soil erosion and sediment control program with the following provisions: (1) progressive standards aimed at reducing agricultural erosion to 'tolerable' soil loss levels by the year 2000; (2) a complaint program tied to the standards; (3) a cost share program tied to complaints. State priority areas, especially lake watersheds, are addressed through a cooperative selection process and watershed work plans. Water quality goals are incorporated in watershed work plans. This approach has provided a balance between both State mandated soil conservation and water quality conservation goals. Examples are presented of this approach. (See also W88-01083) (Author's abstract)
W88-01173

GROUND WATER QUALITY STANDARDS,
Nebraska State Dept. of Environmental Control, Lincoln.
U. G. Hutton.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 464-465.

Descriptors: *Groundwater quality, *Water quality standards, *Nebraska, Groundwater pollution, Drinking water, Water supply.

Contaminated groundwater is difficult, if not impossible to restore. Water quality standards do not protect this resource, but they should serve as the basis for a program preventing contamination. In Nebraska, where groundwater use as a drinking water supply is even higher than the national average, standards and regulations are being revised to support each other as part of a more comprehensive water protection program. New standards are being written, where needed, under a Standards implementation strategy that identified existing gaps in data needed to draw up better standards. (See also W88-01083)
W88-01174

MANAGEMENT PRACTICES TO REDUCE FARM CHEMICAL LOSSES WITH AGRICULTURAL DRAINAGE,
Iowa State Univ., Ames. Dept. of Agricultural Engineering.
J. L. Baker.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 467-470, 1 tab, 19 ref.

Descriptors: *Nonpoint pollution sources, *Water pollution control, *Water quality management, *Agricultural runoff, Pesticides, Nutrients, Nitrates, Nitrogen, Classification, Chemicals, Agricultural watersheds, Conservation, Monitoring, Water quality control.

Field losses of nutrients and pesticides with surface runoff represent concerns for the quality of receiving water with respect to aquatic life and human consumption. Movement of nitrate-nitrogen and possibly pesticides through the soil profile with excess precipitation can affect the quality of groundwater through deep percolation or surface water resources through shallow subsurface drainage. The fate of a soil-applied chemicals relative to these modes of loss is highly dependent on the chemical's persistence and interaction or absorption to the soil. Chemicals are classified as to major mode of loss (sediment, surface runoff water, or subsurface drainage) and reasonable management practices will be considered to control losses for each class. Conservation tillage; timing and methods of chemical application; chemical, formulation, and additive choices; and monitoring to reduce chemical application are discussed. (See also W88-01083)
W88-01175

INTERACTION OF BIOLOGICAL AND HYDROLOGICAL PHENOMENA THAT MEDIATE THE QUALITIES OF WATER DRAINING NATIVE TALLGRASS PRAIRIE ON THE KONZA PRAIRIE RESEARCH NATURAL AREA,
Savannah River Ecology Lab., Aiken, SC.
For primary bibliographic entry see Field 5B.
W88-01177

GREAT LAKES POLLUTION FROM LAND USE ACTIVITIES,
Soil Conservation Society of America, Ankenny, IA.
For primary bibliographic entry see Field 4C.
W88-01179

IRRIGATION RETURN FLOWS AND SALINITY PROBLEMS IN THE COLORADO RIVER BASIN,
World Resources Inst., Washington, DC.
M. T. El-Ashry.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 495-496.

Descriptors: *Irrigation, *Salinity, *Agricultural runoff, *Colorado River basin, *Nonpoint pollu-

tion sources, *Water quality control, Economic aspects, Salts, Water costs, Water law, Costs.

Soil and water salinity occur in arid regions wherever irrigation is practiced. In the United States, an estimated 20% of all irrigated land, about 4 million ha (10 million acres), suffer from salt-caused yield reductions. Though less serious than pollution from heavy metals or toxic organic compounds, salinity constitutes the most serious water quality problem in the western United States. Land degradation and reduced agricultural productivity are some of the likely downstream effects of high salt content in irrigation water. Over irrigation is due to: (1) pricing of water below its scarcity value, which encourages inefficient water use; (2) poor conditions of irrigation infrastructure, that lead to losses through seepage before the water reaches the crops; (3) irrigator's lack of knowledge of water requirements; and (4) inappropriate water policies or provisions in water laws that serve to discourage conservation. Water laws in most States in the West discourage water conservation, and in many areas irrigators have little incentive to conserve because they cannot apply the saved water to new land. Rate structures can be adjusted to make water quantities exceeding efficient irrigation needs more costly. Such rate structures can use existing or other appropriate base rates for efficient irrigation, and excess funds can be invested in on-farm management measures on a project or a district scale. (Lantz-PTT) (See also W88-01083)
W88-01180

USING IN-STREAM MONITORING STATIONS TO EVALUATE POLLUTION FROM URBAN RUNOFF,
South Dakota School of Mines and Technology, Rapid City. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W88-01183

CONSERVATION SERVICE FIELD OFFICE PROGRAM DELIVERY BY HYDROLOGIC AREAS,
Soil Conservation Service, Champaign, IL.
For primary bibliographic entry see Field 3F.
W88-01184

AGRICULTURAL LAND IMPROVEMENT AND WATER QUALITY IN SOUTH CENTRAL MINNESOTA,
Mankato State Univ., MN. Dept. of Biological Sciences.
H. W. Quade.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 508-514, 1 fig, 6 tab, 33 ref.

Descriptors: *Agricultural conservation, *Land use, *Water quality, *Minnesota, Wetlands, Geomorphology, Agricultural runoff, Drainage, Legislation, Public participation, Legal aspects.

Over the past two decades south central Minnesota has seen a classic confrontation between agricultural and wetlands interests, characterized by polarization and single-issue stances. A third issue proposed is water quality; it is suggested that water quality could bring agricultural and wetlands interests together with a common purpose, land and water improvement. Geomorphic and water quality studies on agricultural drainage systems in south central Minnesota demonstrate a potential for moving in this direction. In fact, legal and legislative imperatives require that water quality be included as a parameter. Water quality can and should be the common denominator for all interests involved. (See also W88-01083) (Lantz-PTT)
W88-01185

IMPROVED DESCRIPTION OF SELECTIVE WITHDRAWAL THROUGH POINT SINKS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
D. R. Smith, S. C. Wilhelms, J. P. Holland, M. S. Dortch, and J. E. Davis.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report E-87-2, March 1987. Final Report. 61 p, 25 fig, 3 tab, 25 ref, 2 append.

Descriptors: *Water quality control, *Selective withdrawal, *Point sinks, *Mathematical studies, *Reservoirs, Stratification, Stratified flow, Geometric analysis.

Many significant studies over the past 35 years have combined to produce the present level of understanding of withdrawal processes. Analytical and empirical relationships have been developed and examined for many different density, flow, and geometric configurations. Analytical work has focused on withdrawal from two-layer or linearly stratified reservoirs. In particular, sidewall and bottom point-sink with-drawal are two geometries that have been extensively investigated. The descriptions developed by most investigators were expressions that reduced to the densimetric Froude number. It is troublesome, however, that the critical Froude numbers in these mathematical descriptions at similar flow conditions vary so greatly. In an effort to reduce the variance in these expresions, the concepts of 'withdrawal angle' and symmetry were used to incorporate the effects of lateral geometry or topography into the critical Froude number description. The development of this relationship greatly simplifies the array of coefficients that is reported in the literature for various outlet configurations and patterns of density stratification. The relationship was developed through analytical evaluation of existing expressions and subsequent laboratory experimental verification. Observed prototype conditions, comparing favorably with predictions made with this technique, further verified its credibility. In the development of this more generalized description of withdrawal, the effects of arbitrary boundary interference were explicitly included. For linear stratification, the developed relationship is descriptive of intermediate withdrawal and withdrawal with arbitrary interference and reduces to the analytical description of bottom or surface withdrawal. Results of experiments verified the applicability of this relationship for all three potential withdrawal conditions (i.e., intermediate, surface or bottom, and arbitrary interference). (Author's abstract)
W88-01191

TECHNIQUES FOR INDUSTRIAL POLLUTION PREVENTION: A COMPENDIUM FOR HAZARDOUS AND NONHAZARDOUS WASTE MINIMIZATION,
North Carolina State Univ., Raleigh. Dept. of Chemical Engineering.
M. R. Overcash.
Lewis Publishers, Inc., Chelsea, MI. 1986. 203 p.

Descriptors: *Hazardous materials, *Waste disposal, *Wastewater treatment, *Water pollution control, *Water pollution prevention, *Industrial wastes, *Waste management, Waste recovery, Wastewater disposal, Chemical treatment, Recycling, Electroplating, Air pollution, Pulp wastes, Food-processing wastes, Textile mill wastes.

This book is a compendium of successful waste elimination schemes which are applicable to a variety of disciplines. It allows quick access to a large number of modifications for waste reduction that can assist in minimizing hazardous and nonhazardous wastes. Section 1 reviews waste minimization technology. Sections 2 through 4 are translations of the foreward, prefatory note and introduction of the French report, 'Clean Technologies of French Industry' followed by a glossary of some terms in Section 5. Section 6 discusses economic calculations in relation to United States and French exchange rates. Section 7 examines industrial pollution prevention in the agriculture and food industries, construction materials industry, chemical manufacturing industry, metallurgy industry, surface treatment industry, textile industry, tanneries industry, and the wood products industry. (Geiger-PTT)
W88-01197

DYNAMIC OPTIMAL LAKE REGULATION FOR QUANTITY AND QUALITY OBJECTIVES,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
B. Loftis, J. W. Labadie, and D. G. Fontane.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 277-281, 3 fig, 5 ref.

Descriptors: *Hydrometeorology, *Lakes, *Water management, *Water quantity, *Model studies, *Reservoir operation, *Water quality, *Optimization, Computer models, Case studies, Simulation analysis.

A computer modeling procedure for determining optimal operating strategies in a system of lakes subject to quality and quantity constraints is presented. Several types of objectives can be considered in the general strategy with the one selected for this study being to minimize adverse water quality impacts. Integrated operation of lakes involves an interplay between port selection in multi-level intake structures, water quality parameters, operational time increments, the number and types of projects in a system, and project purposes. The complex lake operation problem can be decomposed into more limited subproblems, with iterative strategies used to achieve an overall solution. An optimization phase is used to suggest possible operation strategies followed by a simulation phase which evaluates each alternate suggested by the optimization phase. A case study illustrates the complexity of lake operation and the applicability of the solution procedure. (See also W88-01203) (Author's abstract)
W88-01246

APPLICATION OF STATISTICAL LOW FLOW ANALYSIS AS A BASIS FOR WATER QUALITY PLANNING,
Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.
For primary bibliographic entry see Field 2A.
W88-01249

DETOXICATION OF HAZARDOUS WASTE.
For primary bibliographic entry see Field 5D.
W88-01297

HAZARDOUS WASTE DETOXICATION AT CONTRACT WASTE MANAGEMENT FACILITIES,
IT Enviroscience, Concord, CA.
For primary bibliographic entry see Field 5D.
W88-01298

CHEMICAL PROCESSES IN THE INCINERATION OF HAZARDOUS MATERIALS,
National Bureau of Standards (NML), Washington, DC. Chemical Kinetics Div.
For primary bibliographic entry see Field 5D.
W88-01299

COMBUSTION CHARACTERISTICS OF CHLORINATED HYDROCARBONS,
Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W88-01300

USING SOLIDIFICATION AS A WASTE DETOXICATION PROCESS,
Weston (Roy F.), Inc., Woburn, MA.
For primary bibliographic entry see Field 5D.
W88-01302

FEDERAL POLYCHLORINATED BIPHENYL REGULATIONS,
Environmental Protection Agency, Washington, DC. Office of Pesticides and Toxic Substances.
For primary bibliographic entry see Field 6E.
W88-01303

TREATMENT AND DESTRUCTION OF POLYCHLORINATED BIPHENYLS AND POLYCHLORINATED BIPHENYL-CONTAMINATED MATERIALS,
Acurx Waste Technologies Corp., Cincinnati, OH.
For primary bibliographic entry see Field 5D.
W88-01304

INCINERATION OF CHEMICAL WASTES CONTAINING POLYCHLORINATED BIPHENYLS: ASSESSMENT OF TESTS CONDUCTED AT ROLLINS ENVIRONMENTAL SERVICES, DEER PARK, TEXAS, AND ENERGY SYSTEMS COMPANY, EL DORADO, ARKANSAS,
Wright State Univ., Dayton, OH. Brehm Lab.
For primary bibliographic entry see Field 5D.
W88-01305

ULTIMATE DISPOSAL OF POLYCHLORINATED BIPHENYLS,
Royal Military Coll. of Canada, Kingston (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W88-01306

CHEMICAL DESTRUCTION OF POLYCHLORINATED BIPHENYLS IN TRANSFORMER OIL,
General Electric Co., Schenectady, NY. Research and Development Center.
For primary bibliographic entry see Field 5D.
W88-01307

LIGHT-ACTIVATED REDUCTION OF CHEMICALS FOR DESTRUCTION OF POLYCHLORINATED BIPHENYLS IN OIL AND SOIL,
Atlantic Research Corp., Alexandria, VA.
For primary bibliographic entry see Field 5D.
W88-01308

CATALYZED WET OXIDATION OF HAZARDOUS WASTES,
IT Enviroscience, Inc., Knoxville, TN.
For primary bibliographic entry see Field 5D.
W88-01309

SELECTED LEGAL ASPECTS OF A DIOXIN DETOXICATION PROJECT,
Syntex Research, Inc., Palo Alto, CA.
For primary bibliographic entry see Field 6E.
W88-01312

PROCESS FOR DESTROYING TETRACHLORODIBENZO-P-DIOXIN IN A HAZARDOUS WASTE,
IT Enviroscience, Inc., Knoxville, TN.
For primary bibliographic entry see Field 5D.
W88-01313

ENVIRONMENTAL HEALTH AND SAFETY CONSIDERATIONS FOR A DIOXIN DETOXICATION PROCESS,
Syntex Research, Inc., Palo Alto, CA.
For primary bibliographic entry see Field 5D.
W88-01314

OPPORTUNITIES FOR DEVELOPMENT OF NEW DETOXICATION PROCESSES THROUGH GENETIC ENGINEERING,
Illinois Univ. at Urbana-Champaign. Inst. for Environmental Studies.
For primary bibliographic entry see Field 5D.
W88-01315

POTENTIAL ROLE OF GENETICALLY ENGINEERED MICROORGANISMS TO DEGRADE TOXIC CHLORINATED HYDROCARBONS,
Battelle Columbus Labs., OH.
For primary bibliographic entry see Field 5D.
W88-01316

MICROBIOLOGICAL SEPARATION FOR TRACE-ORGANICS REMOVAL,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W88-01317

PROCEEDINGS: CE WORKSHOP ON RESERVOIR RELEASES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
Available from the National Technical Information Service, Springfield, VA. 22161. Miscellaneous Paper E-87-3, July 1987. Final Report. 168 p.

Descriptors: *Reservoir operation, *Reservoir releases, *Hydraulic design, *Water quality control, Tailwater, Hydraulic structures, Reservoirs.

During 28-30 October 1986, a workshop on reservoir releases was conducted in Atlanta, Georgia. The objective of the workshop was to provide a forum for the exchange of information related to reservoir release water quality problems, potential solution techniques, and evaluation or predictive techniques. Papers were solicited from across the Corps of Engineers (CE), the Bureau of Reclamation, and the Tennessee Valley Authority on reservoir releases and enhancement/improvement techniques. Twenty-seven papers were presented in five categories: (1) Water quality policy; (2) measurement, evaluation, and prediction techniques; (3) operational and tailwater techniques; (4) in-structure techniques; and (5) in-reservoir techniques. Generalized and specific case studies were topics in each category. (See W88-01320 thru W88-01343) (Author's abstract)
W88-01319

TVA RESERVOIR RELEASE IMPROVEMENTS: AN OVERVIEW,
Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.
B. W. Brown.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 15-18.

Descriptors: *Tennessee Valley Authority, *Reservoir releases, *Water quality control, *Reservoir operation, Dissolved oxygen, Streamflow, Fisheries.

Tennessee Valley Authority (TVA) efforts to improve the quality of reservoir releases from major dams in the Tennessee Valley involve improvement of dissolved oxygen levels in reservoir releases and steps to provide a minimum stream flow below TVA dams. These and other efforts are not to be understood in isolation but as part of a total concern for water quality in the region. Without a commitment to total water quality, such technological fixes would simply be stopgap measures, doomed to be overwhelmed eventually by the pressures of industrial expansion and population growth. Obviously, improving oxygen content of water below TVA dams and guaranteeing a minimum flow in the stream provide fishery benefits. Fish and the aquatic organisms on which they feed need oxygen and minimum amounts of flowing water in order to thrive. Not only do the fish have better quality water in which to live, but insects and other aquatic life important to fish thrive better under such conditions. There is a broader range of considerations than fishery development, however, behind these efforts at reservoir release improvement. Just about everyone in the Tennessee Valley region -- all 7 million people -- have a stake in water quality improvement and protection in one sense or another. The economic well-being of the region is wrapped up in the health of its water resources. An abundance of water has long been a major selling point for the Tennessee Valley when industrial recruiters go looking for prospects. (See also W88-01319) (Lantz-PTT)
W88-01321

STATUS OF THE WATER QUALITY CONTROL MISSION IN ORD AND NEEDS FOR RESEARCH SUPPORT,
Army Engineer Div. Ohio River, Cincinnati.
M. Anthony.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 19-21.

Descriptors: *Water quality control, *Ohio River basin, *Research priorities, *Reservoir operation, *Water quality control, Water quality, Databases, Reservoir releases.

Water quality control is a significant, integral aspect of the water control mission in the Corps of Engineers Ohio River Division (ORD). The location and resources of this basin resulted in early extensive development and subsequent major problems with polluted streams. The Corps of Engineers was involved in two major studies of pollution in this basin (1920's and 1930's) prior to any reservoir construction in the basin. While flood control was the primary focus of the 1938 Flood Control Act which authorized construction of a large reservoir system in this basin, water pollution control was also cited as a major benefit. Subsequent authorization of specific projects have established water quality control storage as well as storage for low-flow augmentation. A major improvement in water quality control resulted from incorporating selective withdrawal capability at storage projects constructed during the last 20 years. This feature allows ORD to more closely comply with stream standards than at projects with only a capability for bottom releases. While districts were collecting at least some water quality data for reservoir regulation guidance during the 1960's, an intensive effort was initiated in 1967. A long-range plan was carefully developed along with specific objectives and priorities and an organized data collection effort began. The basic strategy was to acquire an adequate data base at all projects, employ interpretative techniques abetted by an understanding of hydrodynamics and hydrometeorological conditions in order to anticipate and respond to the quality of storage when scheduling reservoir releases. The success of this strategy along with very careful coordination with state agencies has allowed the ORD to avoid controversy, litigation and crash mitigation efforts. At the present time, are attempting to further refine all of the procedures associated with water quality control. With current access to a multitude of more precise and eloquent procedures developed through the Environmental Water Quality Operations Study Research Programs, many of which have already been integrated into the program. However, further integration or utilization of this improved technology is proving difficult because of the limited size of district staffs and the level of difficulty posed by the complexity and sophistication of some of the latest computerized analytical techniques. (See also W88-01319) (Lantz-PTT)
W88-01322

WESTEX REVISITED: PREDICTED VERSUS OBSERVED RESERVOIR TURBIDITY,
Army Engineer District, Portland, OR.
D. W. Larson, and J. D. Graham.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 23-28, 5 fig, 2 tab, 14 ref.

Descriptors: *WESTEX, *Turbidity, *Reservoirs, *Water quality, *Rogue River basin, *Reservoir operation, *Oregon, Simulation analysis, Mathematical models, Mathematical studies.

Reservoir turbidity was simulated with a mathematical model called WESTEX during preimpoundment water quality studies of the Rogue River Basin in southwestern Oregon. The main objective of this simulation was to predict the turbidity of reservoir release flows for a variety of operating schemes and watershed hydrological conditions. A comparison between observed data after the project became operational with simulated data shows that the WESTEX predictions had been very high and, hence, that the reservoir's turbidity potential had been greatly overestimated. WESTEX's unreliability raises questions about the value of turbidity assessments which depend solely on mathematical modeling. Suggestions are offered

as to how studies to determine turbidity potential might be made more reliable and effective. (See also W88-01319) (Author's abstract)
W88-01323

WATER QUALITY MODELING OF REGULATED STREAMS,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
M. S. Dortch, J. L. Martin, M. J. Zimmerman, and D. E. Hamlin.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 29-34, 3 fig, 10 ref.

Descriptors: *Water quality, *Model studies, *Reservoir operation, *Stream pollution, Stream regulation, Mathematical models, Water analysis, STEADY, QUAL-II, CE-QUAL-REV1, Reservoir releases, Tailwater.

Environmental consequences of construction of new water resource projects or changes in operations of existing projects must be addressed. A variety of tools developed during the Environmental and Water Quality Operational STudies (EWQOS) program may be used to assess impacts of regulation on stream water quality. These techniques range from simple analytical models to more sophisticated unsteady flow water quality models. Model applications have been made to a number of systems in order to address riverine management issues. Several of these applications are discussed to provide an overview of tools available and their possible uses. No single method is appropriate for addressing all water quality issues in regulated streams. Differences in stream environments and management issues require that a variety of tools be available for assessing existing or predicting future impacts of reservoir releases and stream regulation. The various stream water quality models discussed here have provided an effective means of addressing reservoir tailwater and stream water quality issues. Each particular model presented (STEADY, QUAL-II, and CE-QUAL-REV1) has its own merits and limitations and should be selected based on the specific needs of an application. Additional research is presently underway to better identify and describe factors influencing the quality of reservoir tailwaters. An additional tool under development is the system for Management and Analysis of Tailwater Quality, which will provide a user-friendly method of estimating, with limited input data requirements, effects of reservoir releases on downstream water quality. The need for such information and techniques to aid in understanding and managing our reservoir tailwaters and regulated streams becomes increasingly important as attempts are made to increase benefits obtained from these projects. (See also W88-01319) (Lantz-PTT)
W88-01324

EFFECTS OF AERATION AND MINIMUM FLOW ON THE BIOTA AND FISHERY OF NORRIS TAILWATER,
Tennessee Valley Authority, Knoxville.
D. M. Hill, and W. M. Seawell.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 35-40, 7 fig, 3 tab, 8 ref.

Descriptors: *Reservoir operation, *Aeration, *Biota, *Norris Reservoir, *Water quality control, Tailwater, Dissolved oxygen, Flow profiles, Fisheries.

Seasonal aeration of the releases from Norris Reservoir beginning in 1981 and an increased minimum flow of 5.7 cu m/sec (200 cu ft/sec) dramatically improved dissolved oxygen and flow conditions in the 22.5 km (14 mi) reaching of the tailwater. With these improvements some beneficial changes in the tailwater biota have also occurred. Invertebrates which are more sensitive to environmental perturbations and desirable as fish food (caddisflies, mayflies, stoneflies, crayfish and snails) began to occur more frequently throughout the tailwater beginning in 1985. The delayed and incomplete recovery may be a result of DO levels which are still below threshold levels for survival and reproduction of some sensitive benthic species, the scarcity of available colonizers, or a longer than expected time required for full recovery. Fishing pressure, catch rate, and total annual harvests, increased significantly during aeration and following increased minimum flow in the tailwater. These increases are believed to be due to an increased public awareness off efforts to improve the fishery; improved DO during critical periods of the year; more stable, esthetically pleasing flow conditions; increased trout stocking; and improved access around the weir. (See also W88-01319) (Lantz-PTT)
W88-01325

LAKE GREESON AND LITTLE MISSOURI RIVER MODELING STUDIES,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
D. R. Johnson.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 51-56, 8 fig, 1 tab, 6 ref.

Descriptors: *Lake Greeson, *Missouri River, *Model studies, *Arkansas, *Reservoir operation, *Water quality control, Hydraulic models, Model studies, Hydraulic properties, Weirs, Hydraulic structures, Mathematical studies, Mathematical models.

Lake Greeson, Arkansas, was modeled with the numerical model CE-QUAL-R1. The modeling study evaluated the merit of attaching steel plates to the trash racks in order to create a skimmer weir. The plan was considered as part of the Arkansas Lakes Interim Study as a means to increase from Narrows Dam. The numerical model, CE-QUAL-RIV1 was then used to evaluate the effects of warmer releases upon the water quality of the Little Missouri River. The results of the modeling studies were favorable, indicating likely success of the plating proposal to improve water quality in the Little Missouri River. The major difficulty in using both models was obtaining all the necessary data to accurately run the models. BOth studies were conducted using existing data, which were at times outdated or incomplete. These are constraints that most Districts must occasionally handle. The favorable results of the studies indicate no major impacts to the reservoir as a result of plating the trash racks and that the water quality in the Little Missouri River would be measurably improved. (See also W88-01319) (Lantz-PTT)
W88-01327

HOWARD A. HANSON RESERVOIR, WASHINGTON, TEMPERATURE ANALYSIS MATHEMATICAL MODEL INVESTIGATION,
M. L. Schneider, and R. E. Price.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 57-63, 7 fig, 9 ref.

Descriptors: *Howard A. Hanson Reservoir, *Reservoir operation, *Hydraulic properties, *Model studies, *Water quality control, *Water temperature, *Mathematical models, *Washington, Water storage, Hydraulic models, Hydraulic structures, Mathematical studies, Reservoirs.

The US Army Engineer District, Seattle (NPS), is presently evaluating proposed additional water storage at Howard A. Hanson Reservoir in Washington State. This proposed project will involve raising the existing pool approximately 12 m (40 ft). This investigation examined the impacts of raising the conservation pool on the reservoir thermal profiles and release temperatures for several study years. The mathematical model used in this study examined impacts of raising the pool with and without structural modification to the existing outlet works. Optimization procedures were used with the mathematical model to provide optimum number and elevations for the additional ports. Results indicate significant improvement in release temperatures could be achieved with a multilevel outlet structure. (See also W88-01319) (Author's abstract)
W88-01328

WATER QUALITY MONITORING USING SATELLITE DATA TRANSMISSION,
Water and Power Resources Service, Denver, CO. Engineering and Research Center.
S. D. Hiebert.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 65-69, 2 fig, 6 ref.

Descriptors: *Water quality, *Monitoring, *Data acquisition, *Satellite technology, *Reservoir operation, *Bighorn River, *Montana, *Yellowtail Afterbay Dam, Hydrologic properties, Measuring instruments, Computers, Water quality control.

Instruments to monitor and transmit total dissolved gas, dissolved oxygen, water temperature, pH, conductivity, and oxidation-reduction potential (ORP) data have been installed at two sites below Yellowtail Afterbay dam on the Bighorn River, Montana. Data collected with these instruments are being used as part of along-term study of the effects of nitrogen supersaturation on fish and aquatic macroinvertebrates. Water quality measuring instruments are interfaced with a satellite transmittal system so that data gathered are transmitted and readily available for review and analysis using a receiving station computer. Power supply and instrument circuit modifications have been made to ensure the compatability of the systems components. These electronic modifications were the result of field experimentation and recommendations by instrument manufacturers. The correlation of continually monitored dissolved gases and other water quality parameters with dam operations will contribute information to be used in considering modifications in operations which would enhance conditions for aquatic fauna downstream of the dam. (See also W88-01319) (Author's abstract)
W88-01329

DISSOLVED OXYGEN STUDIES BELOW WALTER F. GEORGE DAM,
Army Engineer District, Mobile, AL.
D. I. Findley, and K. Day.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 71-76, 3 fig, 2 ref.

Descriptors: *Dissolved oxygen, *Walter F. George Dam, *Water quality control, *Reservoir operation, *Environmental effects, Reservoirs, Dams, Turbines, Spillways.

A special study of conditions within and downstream from Walter F. George Lake (Al-GA) was conducted from 13-19 August 1986, in response to numerous fish kill incidents that have occurred in the tailrace. The study focused on the suspected cause of the problem, low dissolved oxygen water apparently leaked into the tailrace and moved up through the water column and subsequently downstream. A compressed turbine startup sequence proved to be the most beneficial startup method. Releases through the spillway gates during nongeneration periods offered the most feasible results in preventing or alleviating downstream depressed dissolved oxygen condition. (See also W88-01319) (Lantz-PTT)
W88-01330

PROVIDING MINIMUM FLOWS BELOW HYDROPOWER PROJECTS,
Tennessee Valley Authority, Norris. Engineering Lab.
H. M. Goranflo, and J. S. Adams.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 77-84, 2 fig, 2 tab, 7 ref.

Descriptors: *Minimum flow, *Hydroelectric power, *Dams, *Norris Reservoir, *Reservoir operation, *Water quality control, *Tims Ford Dam, Peak flow, Tailwater, Hydraulic turbines, Flow profile.

Many hydropower facilities are operated only during a portion of the day to meet peak system power demands. Sometimes, during portions of the year when system power demands are low, no

releases are made for several days at a time. Such periods without flow can seriously damage aquatic life in the tailwater. Discussed here are two projects where continuous minimum flows are provided year around. The first is the Norris project where a minimum flow of 5.7 cu m/s (200 cfs) is provided by a reregulating dam located approximately 2.4 km (1.5 mi) below the main dam. The other is the Tims Ford project where a minimum flow of 2.3 cu m/s (80 cfs) will be provided through a small hydroturbine operating during periods when the main turbine is shut down. The paper addresses the alternatives evaluated at each project and the design, construction, and operation of the minimum flow systems. (See also W88-01319) (Author's abstract)
W88-01331

SELECTIVE WITHDRAWAL STRUCTURE OPERATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
J. E. Davis, and S. C. Wilhelms.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 85-88, 6 fig, 5 ref.

Descriptors: *Reservoir operation, *Selective withdrawal, *Hydraulic structures, *Water quality control, *Model studies, Water temperature, Mathematical models, SELECT, Model structures.

Reservoir personnel operating multilevel selective withdrawal outlet structures often have difficulty determining the daily outlet operations required to yield a desired release temperature. Four techniques designed to determine day-to-day outlet structure operations are compared, that will yield a particular reservoir release temperature given a specific outlet works configuration and various reservoir conditions. Data from a stratification season of approximately 8 months were used in the comparison. Given the prescribed optimal operating scheme of each technique, a mathematical description of selective withdrawal was used to predict the resulting project release temperatures. The release temperatures produced by each scheme's prescribed operations were compared to the target release temperature, and the most accurate technique was identified. The US Army Corps of Engineers (CE) program SELECT with a port-selection capability was considered the best of the four techniques. SELECT is a one-dimensional, user-oriented numerical model of withdrawal and daily operations that ix executable on a microcomputer, as well as on a mainframe computer. The program is capable off being an integral part of an automated reservoir data collection and structure operation system. (See also W88-01319) (Author's abstract)
W88-01332

APPLICATION ON THE SELCIDE MODEL IN THE NASHVILLE DISTRICT,
Army Engineer District, Nashville, TN.
R. B. Sneed.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 89-91, 3 ref.

Descriptors: *SELCIDE, *Model studies, *Nashville, *Water quality control, *Routing, *Reservoir operation, Mathematical studies, Water temperature, Dissolved oxygen, Lakes, Selective withdrawal, Reservoirs.

The application of the SELCIDE model developed at the Waterways Experiment Station to Corps of Engineers projects in the Nashville District, is discussed. The need to accurately route water quality through a system of ten impoundments on the Cumberland River system is emphasized. The ability to predict the physical and chemical properties of water released from both tributary and main-stem projects using SELCIDE is presented with a series of four case studies. SELCIDE has been used to define the withdrawal zone in lakes, assess the impact of changes in project operation on the withdrawal zone, and to predict the quality off releases for both existing and future conditions. Outflow conditions predicted by SELCIDE compare well with field data. Typically, predicted temperatures are within 0.3 C (0.5 F) of observed values, although differences exceeding 1.0 C (1.8 F) have been observed. Differences between predicted and observed dissolved oxygen values tend to be somewhat greater. This can be explained in part by the differing turbine reaeration characteristics found among Corps of Engineers projects. These differences range up to about 1.5 mg/L, however differences of 0.5 mg/L are more the norm. (See also W88-01319) (Lantz-PTT)
W88-01333

SYSTEM SPILL ALLOCATION FOR THE CONTROL OF DISSOLVED GAS SATURATION ON THE COLUMBIA RIVER,
Army Engineer Div. North Pacific, Portland, OR.
B. Tanovan.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 93-100, 5 fig, 4 tab, 1 ref.

Descriptors: *Reservoir operation, *Columbia River, *Dissolved gas, *Water quality control, *Spillways, Model studies, Hydraulic properties, Simulation analysis, GASSPIL, Selective withdrawal.

Spill schedules for the Columbia/Snake River dams are developed and dispatched from the Corps North Pacific Division's Reservoir Control Center in Portland. During the spring and summer, spill is usually required not only because of high runoff in excess of project hydraulic capacity and reduced power demands but also to provide a safer passage route for fish past mainstem dams. This has often resulted in high dissolved gas saturation levels that are detrimental to fish. A system optimization procedure has been developed for use with an existing N2 simulation model to determine where and how much to spill to minimize high localized gas problems and ensure the system power output is met. The combined analytical tool consists of three major components to simulate N2 saturation in spillway-stilling basins, in reservoirs, and to control the procedure for developing optimal spill allocation. The model, code-named GASSPIL, is directly linked to a real-time data base system and can be used for planning as well as actual operational spill management. (See also W88-01319) (Author's abstract)
W88-01334

SIMULTANEOUS MULTIPLE-LEVEL WITHDRAWAL THROUGH SINGLE WET WELL STRUCTURES FOR DOWNSTREAM WATER QUALITY MAINTENANCE,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
S. E. Howington.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 101-107, 9 fig, 2 ref.

Descriptors: *Selective withdrawal, *Water quality, *Hydraulic properties, *Reservoir operation, *Water quality control, *Flow profiles, Intakes, Theoretical analysis, Hydraulic head.

The concept of selectively withdrawing from multiple levels simultaneously in a stratified reservoir is presented and its usefulness discussed. The problem of predicting the flow distribution between the withdrawal levels under various operating conditions is outlined. The theory applies well in all cases tested thus far. These cases include a variety of sizes and types of intake structures. For those situations in which quantitative comparisons are possible, the theory is accurately predicting flow distributions between the port elevations. In those cases where only qualitative analyses are possible, the trends of the observed data and the theory compare favorably. Further testing of the theory is planned under an ongoing research effort. Situations are being sought in which the theory does a less than adequate job of prediction so that these can be accounted for in the formulation. (See also W88-01319) (Lantz-PTT)
W88-01335

SINGLE WET WELL BLENDING AT APPLEGATE LAKE, OREGON,
Army Engineer District, Portland, OR.
J. D. Hanson, and R. A. Cassidy.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 109-115, 7 fig, 2 tab.

Descriptors: *Wet wells, *Applegate Lake, *Oregon, *Water quality control, *Reservoir operation, Water temperature, Mixing.

In 1983, the Portland District performed experimental reservoir releases using one half of the dual wet well selective withdrawal system at Applegate Lake to evaluate the potential for blending water in a 1.5 m (5 ft) diameter single wet well. The reservoir water located in the epilimnion was approximately 18 C (65 F) and the hypolimnion water, 27 m (90 ft) deeper in the reservoir, was near 9 C (49 F). Successful water temperature blending was achieved for two days with a wide variety of gate opening combinations, at the test release flow of 14.2 cu m/s (500 cu ft/s). In 1986, an operational study was performed to test single wet well mixing at 4.8 cu m/s (170 cu ft/s). A constant water temperature near the target release temperature of 12.8 C (55 F) was maintained for eight days. The reservoir water temperatures at the operating ports were 16 C to 18 C (60 to 65 F) near the surface and 7 to 8 C (44 to 46 F) near the bottom. (See also W88-01319) (Author's abstract)
W88-01336

RECENT DEVELOPMENTS IN TURBINE AERATION,
Tennessee Valley Authority, Norris. Engineering Lab.
E. D. Harshbarger.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 117-120, 27 ref.

Descriptors: *Turbines, *Aeration, *Hydraulic structures, *Reservoir operation, *Water quality control, Hydraulic turbines, Diffusers, Draft tube air aspiration, Baffles, Pumps.

Since the early 1970's, the Tennessee Valley Authority has been investigating methods for aerating hydroturbine discharges. Techniques which have been physically tested include small pore diffuser, draft tube air aspiration, vacuum breaker modifications, hub baffles, draft tube forced air systems and epilimnetic pumps. These tests are briefly described and the results obtained are discussed. The conclusions are that to a large extent, aeration methods are site specific and no universal solution can be applied. Efforts toward the development of new turbines specifically designed for aeration are suggested. (See also W88-01319) (Author's abstract)
W88-01337

OXYGENATION OF RELEASES FROM RICHARD B. RUSSELL DAM,
Army Engineer District, Savannah, GA.
J. W. Gallagher, and G. V. Mauldin.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 121-124, 2 fig, 6 ref.

Descriptors: *Oxygenation, *Richard B. Russell Dam, *Reservoir releases, *Water quality control, *Aeration, *Reservoir operation, Reservoirs, Lakes.

During the early planning stages of the Russell project, a major concern of the State and Federal agencies was that the project comply with State water quality standards. The Corps of Engineers committed itself to this objective and developed a diffused oxygen injection system to oxygenate the reservoir releases. At Richard B. Russell Lake, oxygen is injected into the lake through fine pore diffusers located on the bottom of the lake both at the face of the dam and 1 mile upstream from the dam. Documented here is the interagency involvement in the oxygen injection system, summarizing the results of the field tests which led to the

development of the system. The installation and operation of the system installed in Richard B. Russell Lake is described. (See also W88-01319) (Author's abstract)
W88-01338

IN-RESERVOIR AERATION SYSTEMS,
Tennessee Valley Authority, Chattanooga.
C. E. Bohac.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 125-132, 16 fig, 1 tab, 2 ref.

Descriptors: *Aeration, *Reservoir operation, *Water quality control, *Bear Creek Reservoir, *Alabama, Hydrogen sulfide, Reservoirs, Lakes.

Two types of aeration systems are being demonstrated by the Tennessee Valley Authority. The first is an aeration/destratification system using diffused air. The system is installed at Upper Bear Creek Reservoir, Alabama. The system is designed to increase DO levels in the reservoir as well as reduce concentrations of iron, manganese, and hydrogen sulfide in the withdrawals from the reservoir. The second system is a hypolimnetic aeration system using high purity oxygen. The system is designed to aerate only a small submerged pool of cool water in an embayment of a large reservoir. The embayment acts as a refuge for fish during times when the main reservoir body is anoxic and fish are stressed. (See also W88-01319) (Author's abstract)
W88-01339

EPILIMNETIC PUMPS TO IMPROVE RESERVOIR RELEASES,
Tennessee Valley Authority, Norris. Engineering Lab.
M. H. Mobley, and E. D. Harshbarger.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 133-135, 14 ref.

Descriptors: *Epilimnetic pumps, *Reservoir releases, *Water quality control, *Reservoir operation, *Douglas Reservoir, Pumps, Dissolved oxygen, Epilimnion, Headwater elevation, Destratification, Seasonal variation.

The Tennessee Valley Authority has installed high volume, low speed, axial pumps in Douglas Reservoir just upstream from the turbine intakes. The purpose of these pumps is to force highly oxygenated epilimnetic surface water into the turbine intakes when the reservoir is thermally stratified and the bottom water is low in dissolved oxygen. Tests to date have been run only in low headwater elevation, destratified conditions; therefore, the effectiveness of the pumps under strongly stratified conditions at summer levels is still unknown. However, the pumps have performed well thus far and show promise for success next spring. (See also W88-01319) (Lantz-PTT)
W88-01340

LOCAL DESTRATIFICATION SYSTEM FOR MARK TWAIN LAKE,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
S. C. Wilhelms, and T. J. Furdek.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 137-141, 4 fig, 4 ref.

Descriptors: *Destratification, *Mark Twain Lake, *Water quality control, *Pumps, *Lake rehabilitation, *Reservoir operation, Dissolved oxygen, Water temperature, Thermocline, Lakes.

Releases during start-up of generation at Mark Twain Lake (MTL) have been cold and low in dissolved oxygen. During periods of no generation, cold poor-quality water has gradually accumulated in the turbine tailbay. The authors present observed data and describe the processes that resulted in these observations. The mini-lake, which is the region in MTL between the main dam and the temperature control weir (TCW), restratifies when generation ceases if the lake thermocline and oxycline are above the elevation of the TCW. The authors present solutions and recommend that a hydraulic destratification system be installed to destratify the minilake. The design parameters and constraints are shown and the system design is developed. The recommended design for the destratification cation system is for five subsystems. Each subsystem would consist of a pump capable of delivering 0.46 cu m/s (5 cu ft/s) at 15.2 m (50 ft) of pressure head feeding a 30.5-cm- (12-in.-) diameter 24.4-m- (80 ft) long diffuser pipe with 13-mm-(1/2-in.) diameter ports bored 30.5 cm (1-ft) on centers. This design would provide the necessary volume and momentum to satisfy the destratification requirements. PVC schedule 40 pipe should fulfill the strength and corrosion resistance requirements of the design. In addition to providing the diffuser support, the piping and framework serve as ballast and anchoring weight and flotation system. (See also W88-01319) (Lantz-PTT)
W88-01341

LAKE ALLATOONA - AN EARLY EXPERIENCE IN DESTRATIFICATION REVISITED,
Corps of Engineers, Mobile, AL. Mobile District.
N. D. McClure.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 143-149, 2 fig, 3 tab, 6 ref.

Descriptors: *Lake Allantoona, *Destratification, *Water quality control, *Georgia, *Lake rehabilitation, *Reservoir operation, Dissolved oxygen, Reservoir releases, Stratification.

In 1968, a rather bold experiment in lake destratification was undertaken in hope of demonstrating a viable approach for improving the dissolved oxygen (DO) concentrations in release waters from hydropower dams. Lake Allatoona in North Georgia was selected for a prototype installation to determine if the concept could be utilized for the then proposed West Point Project on the Chattahoochee River downstream from Atlanta. The approaches for design, fabrication, and installation of the system are presented along with a review of the State of the Art that existed at that time. The operational and testing programs are discussed and the results produced are presented. In general, the normal stratification pattern of the lake was altered to the extent that DO concentrations were increased at depths from 9.1 to 24.4 m (30 to80 ft). The DO concentrations in the release waters were also increased. Because of the water quality improvements, especially increased DO concentrations, the originally envisioned temporary experimental test was operated for the past 19 years. Operational experiences and costs are discussed. A summary analysis of the overall experience is presented, including views on how the system could be improved if it were installed today. (See also W88-01319) (Author's abstract)
W88-01342

PNEUMATIC DIFFUSERS,
Bureau of Reclamation, Denver, CO.
P. L. Johnson.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 151-158, 8 fig, 19 ref.

Descriptors: *Pneumatic diffusers, *Water quality control, *Reservoirs, *Reservoir operation, *Aeration, *Destratification, Dissolved oxygen.

Pneumatic diffusers are devices which aerate and destratify reservoirs through the use of free air bubble plumes. They are widely used to enhance the quality of reservoir water and reservoir releases. Experience indicates that pneumatic diffusers offer a proven and cost effective treatment technique. They function by upwelling oxygen depleted hypolimnion water toward the surface where it mixes with oxygen rich metalimnion and epilimnion water. Use of pneumatic diffusers results in varying degrees of destratification depending on the design. A limited overview of pneumatic diffusers is presented, including discussions of basic theory, possible resulting reservoir impacts, design, and documented field experience. (See also W88-01319) (Author's abstract)
W88-01343

GALERKIN-FINITE ELEMENT TWO-DIMENSIONAL TRANSPORT MODEL OF GROUNDWATER RESTORATION FOR THE IN SITU SOLUTION MINING OF URANIUM,
Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 5B.
W88-01360

BIODEGRADATION AND DETOXIFICATION OF ENVIRONMENTAL POLLUTANTS.
For primary bibliographic entry see Field 5B.
W88-01369

MICROBIAL METABOLISM AND ENZYMOLOGY OF SELECTED PESTICIDES,
Oklahoma Univ., Norman. Dept. of Botany and Microbiology.
For primary bibliographic entry see Field 5B.
W88-01370

MICROBIAL DEGRADATION OF POLYCHLORINATED BIPHENYLS (PCBS),
Fermentation Research Inst., Yatabe (Japan).
For primary bibliographic entry see Field 5B.
W88-01371

CHEMICAL TRANSFORMATIONS OF AROMATIC HYDROCARBONS THAT SUPPORT THE GROWTH OF MICROORGANISMS,
University Coll. of North Wales, Bangor. Dept. of Biochemistry and Soil Science.
For primary bibliographic entry see Field 5B.
W88-01372

GENETIC AND BIOCHEMICAL BASIS FOR MICROBIAL TRANSFORMATIONS AND DETOXIFICATION OF MERCURY AND MERCURIAL COMPOUNDS,
Washington Univ., St. Louis, MO. Dept. of Biology.
For primary bibliographic entry see Field 5B.
W88-01373

GENETIC MECHANISMS IN THE DISSIMILATION OF CHLORINATED COMPOUNDS,
Illinois Univ. at the Medical Center, Chicago.
For primary bibliographic entry see Field 5B.
W88-01374

HAZARDOUS WASTE DISPOSAL: ASSESSING THE PROBLEM.
For primary bibliographic entry see Field 5E.
W88-01375

TECKOMATORP, SWEDEN -- WASTE PROBLEMS FROM THE PERSPECTIVE OF A MANUFACTURING INDUSTRY,
National Swedish Environment Protection Board, Solna.
For primary bibliographic entry see Field 5B.
W88-01378

TECKOMATORP, SWEDEN -- WASTE PROBLEMS FROM THE PERSPECTIVE OF A MANUFACTURING INDUSTRY,
Skane County Environmental Office, Malmo (Sweden).
P. Gustafsson.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 37-42, 2 fig.

Descriptors: *Hazardous wastes, *Water pollution treatment, *Waste disposal, *Waste management, *Cleanup, *Sweden, Environmental effects, Industrial wastes, Solid waste disposal, Organic compounds, Public health, Fate of pollutants, Leaching, Soil contamination, Groundwater pollution, Phenols.

After the closing of the factory in Teckomatorp, Sweden, excavations and hydrogeological investigations of the area began. The hazardous wastes that had been buried within the area required cleanup, and the county administration commissioned the Swedish Water and Air Pollution Research Institute to investigate and present alternative solutions for the project. Of the eight different alternatives for cleanup, only three were considered realistic, namely forced leaching, forced leaching and composting, and forced leaching and composting combined with combustion. The heavily concentrated solid wastes will be exported for deposition in underground facilities. Heavily concentrated liquid waste will probably be incinerated. The factory building and the chimney were taken down. The sanitation program will cost $7 million. (See also W88-01375) (Geiger-PTT)
W88-01379

LATHROP, CALIFORNIA: ASSESSING THE PROBLEM,
California Dept. of Health Services, Berkeley. Hazardous Materials Lab. Section.
For primary bibliographic entry see Field 5C.
W88-01381

ANSWER TO ASSESSING HAZARDOUS WASTE PROBLEMS IS COOPERATION,
Occidental Chemical Co., Lathrop, CA. Environmental, Health and Safety.
J. A. Harris.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 68-76, 3 fig.

Descriptors: *Hazardous wastes, *Radioactive wastes, *Water pollution treatment, *Path of pollutants, *Waste disposal, *Project planning, *Groundwater pollution, *Soil contamination, Waste management, Public health, Monitoring, Soil analysis, Environmental effects, Test wells, Radioactive wastes, Hydrologic models.

A plan of study for the assessment of hazardous wastes problems as related to soil and groundwater contamination, in particular those studied by the Occidental Chemical Company at its Lathrop, California facility is presented. The plan of study sets forth a comprehensive approach to systematically determine whether certain chemicals and radiological substances are present in the groundwater and soils in the vicinity of the Occidental Chemical facility. The plan of study consisted of four basic elements: groundwater analysis, soil analysis, domestic well monitoring, and groundwater modeling. Because of the complexity of the study, it was divided into three separate phases. Phase I encompassed that phase of the groundwater and soil analysis program necessary to determine whether any organic, inorganic, or radiological constituents are present in groundwater or soils in the vicinity of the plant. Phase II was that phase of the groundwater and soil analysis program necessary to evaluate the overall effectivenes of any mitigation measures, and define any additional remedial measures needed to be in compliance with waste discharge requirements and protection of public health and the environment. Phase III was that phase of the program conducted after the implementation of mitigation measures that will evaluate on-going compliance with the waste discharge requirements and protection of public health and the environment. Through the development and implementation of a systematic soil and groundwater analysis program, Occidental Chemical Company was able to obtain a comprehensive understanding of the environmental conditions in the vicinity of its Lathrop facility. This program has been very effective due to close coordination between Occidental and governmental agencies. (See also W88-01375) (Geiger-PTT)
W88-01382

SALSBURY LABORATORIES - LA BOUNTY SITE: A PHASED APPROACH TO A HAZARDOUS WASTE DISPOSAL PROBLEM,
National Enforcement Investigations Center, Denver, CO.
T. O. Dahl.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 95-101, 3 fig.

Descriptors: *Path of pollutants, *Water pollution treatment, *Waste disposal, *Hazardous wastes, *Asenic compounds, *Groundwater pollution, *Public health, Leaching, Project planning, Cleanup, Monitoring, Water pollution sources, Water pollution effects, Environmental effects.

Pollution of the Cedar River and groundwater supplies by Salsbury Laboratories, a major manufacturer of veterinary biological and pharmaceutical preparations, feed additives, and intermediate organic chemicals, prompted the Iowa Department of Environmental Quality to monitor the La-Bounty site where the plant is located. As a result of the findings, the Iowa DEQ ordered the plant to cease waste disposal. The laboratories began depositing their wastes in a temporary holding basin. However, within 24 hr leachate was detected in the underdrain system and this arrangement was terminated. The company began collecting and holding wastes for out-of-state shipment and disposal at a state-approved hazardous waste disposal site. A technical investigation during the summer of 1978 revealed high arsenic concentrations in the leachate-contaminated groundwater. Based on these and other findings, the EPA Kansas City Office required Salsbury Laboratories to design and implement necessary remedies which included four phases. Phase I included the installation of an extensive groundwater monitoring system at the LaBounty site. Phase II involved regrading the site to divert surface runoff around the site, rerouting an existing storm sewer around the site, and installing a clay cap over the site. Phase III will divert groundwater through installation of a cutoff wall upgradient of the site. Phase IV included studies on possible in situ stabilization of materials. (See also W88-01375) (Geiger-PTT)
W88-01384

PROTECTING THE WORKER: AN OVERVIEW OF THE PROBLEM,
American Federation of Labor and Congress of Industrial Organizations, Washington, DC.
M. Semenario.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 173-178.

Descriptors: *Hazardous wastes, *Safety, *Water pollution effects, *Project planning, *Waste disposal, *Toxicity, Personnel, Waste dumps, Public health, Human pathology, Monitoring, Training, Decontamination, Cleanup.

As the number of waste dumps that will be cleaned up under the new Superfund legislation increases, more workers will be required to enter hazardous waste disposal areas. Danger from exposure to hazardous materials exists for these workers as well as government officials who will need to enter these areas for the purposes of monitoring cleanup progress, and for existing employees of toxic waste disposal sites. The protective measures afforded workers at the Love Canal site were less than adequate. Concern for worker safety was also encountered at the Hyde Park dump at Bloody Run Creek. The unions representing the workers there asked NIOSH to conduct a health hazard evaluation of the workers in the plants in response to health problems experienced by personnel. When firefighters responded to a fire at a toxic waste cleanup operation in Elizabeth, New Jersey, they were afforded no protective respiratory devices while cleanup workers at the plant were outfitted in full protective clothing. The AFL-CIO has contacted three major agencies that should be involved in addressing such problems - EPA, NIOSH and OSHA. These agencies along with DOT are working on programs to address problems of worker safety and protection at toxic waste dumps. Under the Superfund statute, an Agency for Toxic Substances and Disease Registration has been established that encompasses the work of these four agencies and a number more. (See also W88-01375) (Geiger-PTT)
W88-01391

BRITISH EXPERIENCE-CLEAN UP: TECHNICAL ASPECTS,
UKAEA Atomic Energy Research Establishment, Harwell (England).
E. T. Smith, and J. Bromley.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 188-201, 4 fig, 7 ref.

Descriptors: *Cleanup, *Waste disposal, *United Kingdon, *Hazardous wastes, *Toxic wastes, *Waste dumps, Waste management, Landfills, Land reclamation, Environmental effects, Case studies.

The problems of uncontrolled hazardous waste dumps inherited from the past appear to be less severe in the United Kingdom than in the United States. Reasons suggested for this difference are the higher population density, the existence of planning controls the earlier introduction of legislation, the lower impact of derelict land per head of population, and hydrogeological factors. The problems that do exist can be solved by a combination of a pragmatic approach and good planning controls. The sites in the United Kingdom which cause most concern are open dumps which have been abandoned in a dangerous condition. Such an example is a 30 ha site at Malkins Bank in Cheshire. Paper wastes from the site were removed to a municipal landfill while drums were buried in huge pits dug into the lime wastes. The stream which flowed through the site was culverted and 1.5 m of top soil was brought in to cover the surface which was landscaped for recreational use. Another site bordering an estuary was contaminated with asbestos. Fruit bushes were removed from the site. It was recommended that the site be fitted with a proper sea defense, leveled and covered with fly ash. A site in North Wales was used for disposal of acid tars over many years. The abondoned site caught fire. The fire burnt out of control thereby detoxifying a number of drums by incineration. Further action is planned to stabilize the site. In managing landfills of hazardous wastes in the future the safe placement of the waste, the long term problems of redevelopment, and the prevention of water pollution should be considered. (See also W88-01375) (Geiger-PTT)
W88-01394

REMEDIAL SITE CONTAINMENT,
Conestoga-Rovers and Associates, Waterloo (Ontario).
F. A. Rovers, and M. Jones.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 202-212, 3 fig, 1 tab.

Descriptors: *Toxic wastes, *Cleanup, *Waste disposal, *Leachates, *Fate of pollutants, *Waste management, *Hazardous wastes, Landfills, Leaching, Monitoring, Infiltration, Maintenance.

Industrial waste disposal sites have the potential to cause significant environmental impacts through leaching of toxic substances. Remedial work at such sites can be categorized as on-site remedial containment, or waste removal. On-site containment can involve some, or all of the following remedial work components: waste capping, leachate collection, leachate treatment, gaseous control and treatment, and monitoring and maintenance. Capping requires use of a material of low permeability such as clay which maintains its integrity over a long period of time and reduces infiltration and therefore leachate production. Effective leachate collection in a hydrogeologic environment assumes that the groundwater flow regime can be controlled. Selection of a leachate treatment alternative is based primarily on considerations of effectiveness and cost. Commonly, collected gases at a waste disposal site are treated by either burning or treatment in an activated carbon system. Monitoring of the secured waste disposal facility will provide a measure of both the effectiveness of the installed systems and their need for maintenance. (See also W88-01375) (Geiger-PTT)
W88-01395

RESPONSE CAPACITY – STATE GOVERNMENT,
California Dept. of Health Services, Sacramento.
J. E. Mahoney.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 213-216.

Descriptors: *Waste disposal, *California, *Waste dumps, *Regulations, *Local governments, *Legal aspects, *Hazardous wastes, Landfills, Solid waste disposal, Waste management, Environmental effects, Site selection.

The state of California is faced with a shortage of hazardous waste disposal capacity. A state strategy for siting hazardous waste facilities is needed. The nature of waste disposal sites can be changed in three ways to protect people. First, strict liability can be imposed on the operation of the site so that any damages to the surrounding population can be compensated without the necessity of proving negligence. Second, a state superfund can be established to broaden the scope of the federal Superfund. Third, new technological processes can be developed to prevent the burial in landfill sites of highly toxic materials. Finally the capacity of the state government to respond to hazardous waste issues depends on effective communication and coordination between local residents, local government, and state government. (See also W88-01375) (Geiger-PTT)
W88-01396

EMERGENCY RESPONSE AND PUBLIC HEALTH AT HAZARDOUS WASTE SITES,
Environmental Protection Agency, Washington, DC.
M. B. Cook.
IN: Hazardous Waste Disposal: Assessing the Problem. Ann Arbor Science, Ann Arbor, MI. 1982. p 222-227.

Descriptors: *Public health, *Hazardous wastes, *Toxic wastes, *Waste disposal, *Cleanup, *Environmental effects, Toxicity, Project planning, Waste management, Monitoring, Safety, Legal aspects, Training.

The EPA's hazardous emergency response program and the related issues concerning protection of public health and safety are reviewed. The basic managerial framework of Section 311 of the Clean Water Act is carried over to the Superfund program. EPA's Emergency Response team presently directs a national alerting system for rapid dissemination of information on personal safety and hazard assessment to protect public health and personnel in environmental emergency situations. This is made possible through the NIH/EPA OHM-TADS oil and Hazardous Materials Technical Assistance Data Systems computerized chemical information system. EPA is currently developing an integrated health and safety program for EPA employees involved in hazardous substance cleanup, which may serve as a model for the Interagency Working Group. The major components of this program include: development of generic safety plans for hazardous waste site investigations and spill response which can be tailored to particular incidents; a system of audits to ensure compliance with health and safety requirements; provisions for accident reporting; training requirements; general emergency procedures; criteria for medical surveillance of workers, including preassignment health assessments, periodic health assessments, maintenance of employee medical records for at least 30 yr; and rules concerning personnel practices such as wearing of protective clothing. The Superfund bill established a new agency within the Public Health Service, the agency for Toxic Substances and Disease Registry. The appropriate division of responsibilities and coordination among federal, state, and local government agencies with respect to health studies and registries must be resolved. The nature and scope of federal responsibilitiy for ensuring adequate health care for victims of chemical contamination, and for training of physicians and public health professionals capable of dealing with hazardous waste incidents at the non-federal level must also be defined. (See also W88-01375) (Geiger-PTT)
W88-01398

HAZARDOUS WASTE MANAGEMENT - THE SHARING OF RESPONSIBILITY,
Union Carbide Corp., Washington, DC.
For primary bibliographic entry see Field 5E.
W88-01399

ENVIRONMENTAL ENFORCEMENT: CHANGING THE CORPORATE MIND,
Office of the Associate Attorney General, Washington, DC. Land and Natural Resources Div.
For primary bibliographic entry see Field 5E.
W88-01400

MAN-MADE POLLUTION OF GROUND WATER AND ITS GEOLOGICAL RELATIONS,
For primary bibliographic entry see Field 4B.
W88-01401

GROUNDWATER QUALITY PROTECTION AIDED BY REMOTE SENSING,
For primary bibliographic entry see Field 7B.
W88-01402

TRENDS OF GROUND WATER PROTECTION FROM WASTEWATER SLUDGE POLLUTION IN THE CITY OF MOSCOW,
For primary bibliographic entry see Field 5E.
W88-01403

POLICY, LEGAL AND TECHNICAL MEASURES TO COMBAT POLLUTION OF SOIL AND GROUND WATER FROM NON-POINT SOURCES,
P. J. Reynolds, and L. Fielding.
United Nations, Economic Commission for Europe, WATER/SEM.14/R.5, February 27, 1987. 13 p, 19 ref.

Descriptors: *Nonpoint pollution sources, *Groundwater pollution, *Water pollution control, *Acid rain, *Groundwater management, *Legal aspects, Water pollution sources, Water law, Regulations, Sludge disposal, Waste disposal, Water quality management, Urban runoff, Agricultural runoff.

In terms of abating both point and nonpoint pollution of groundwater and soil, three general strategic approaches using legal and technical means are employed by governments: preventive actions through use of regulations, standards, guidelines, codes of practice and power to approve, limit, prohibit, order, or advise whenever a project affecting groundwater is under consideration; prompt response to contamination incidents; promote principles and general procedures which act against pollution of environmental elements, including groundwater. To enable action on pollution in Canada, each provicne has water resources or environmental legislation which protects both surface and groundwater from different sources of point and nonpoint pollution, and also regulates water use (and waste disposal) in various circumstances. Preventive and remedial measures used in Canada for the control of nonpoint pollution of groundwater from the agricultural sector, urban runoff, transport, and from the air are discussed. Toxic chemical spills involve special environmental protection legislation. Regulations and laws involving dangerous, highly toxic, volatile or other designated substances tend to vary from province to province. A federally-led acid rain action plan presently involves twelve government departments, the provinces, and industries in a research and monitoring program. (Geiger-PTT)
W88-01404

MAIN PRINCIPLES OF THE METHODS IN DEFINING THE ECONOMIC EFFICIENCY OF MEASURES FOR PRESERVING UNDERGROUND WATERS FROM NITRATE POLLUTION AT FERTILIZATION,
For primary bibliographic entry see Field 5B.
W88-01405

MINE WATER.
International Mine Water Association.
For primary bibliographic entry see Field 4B.
W88-01408

ORIGIN AND TREATMENT OF UNDERGROUND WATERS FROM CERRO DE PASCO MINE, PERU,
Centromin Peru S.A., Lima (Peru).
For primary bibliographic entry see Field 5B.
W88-01411

IMPROVING THE QUALITY OF MINE SERVICE WATERS IN GOLD MINES IN SOUTH AFRICA,
Chamber of Mines Research Organisation, Johannesburg (South Africa). Engineering Materials Branch.
G. J. G. Juby, R. C. Harries, and J. D. Greig.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 353-363, 5 fig, 1 tab, 8 ref.

Descriptors: *Acid mine drainage, *Water quality control, *Acidic water, *Mine drainage, Gold mining, Mineral industry, South Africa, Lime, Neutralization, Sulfates, Explosives.

The gold mining industry in South Africa uses about 700,000 tons of lime per year worth about 34 million rand (1 rand = 0.5 U.S. dollar). It is estimated that about ten percent of this is used to neutralize acidic waters underground. A novel alternative means of countering the production of acidity in mine service waters and minimizing the use of lime is discussed. The addition of 30 mg/L sodium lauryl sulfate to mine water, used for wetting down operations on broken ore in a slope, reduced the acidity and sulfates in the return water form the slope. The pH of the water leaving a working slope increased from below 3 to above 5, and the sulfate content decreased by 50% to 90% depending on the wash procedure used. However, the amount of acidity and nitrates produced from the explosives used in mining were not affected by the presence of sodium lauryl sulfate. (See also W88-01408) (Wood-PTT)
W88-01437

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

DEVELOPING NONPOINT SOURCE CONTROL STRATEGIES FOR BIG STONE LAKE: TWO APPROACHES,
Minnesota Pollution Control Agency, Roseville.
For primary bibliographic entry see Field 5G.
W88-01099

POSSIBLE USES OF LONG-RANGE WEATHER OUTLOOKS IN WATER RESOURCES,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 6B.
W88-01239

METHODOLOGY FOR DEVELOPING OPTIMAL WATER STORAGE STRATEGIES,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W88-01242

ECONOMIC GAINS FROM PROBABILISTIC TEMPERATURE FORECASTS,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
M. G. Alexandridis, and R. Krzysztofowicz.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 263-266, 3 tab, 8 ref. NSF Grant No. CEE-8107204.

Descriptors: *Hydrometeorology, *Water demand, *Water demand forecasting, *Economic aspects, *Temperature, *Forecasting, *Probabilistic process, Decision making.

Probabilistic and categorical daily temperature forecasts are evaluated in the context of power load scheduling by an electric utility. Two decision procedures are considered: an optimal one which accounts for forecast uncertainty and a suboptimal one which does not. Probabilistic forecasts are found superior to categorical forecasts because they: (1) result in higher economic gains for both decision procedures, and (2) apprise users that forecasts are inherently uncertain. This latter attribute may impel the sub-optimal users to refine their decision procedures and, consequently, reap still higher economic gains. (See also W88-01203) (Author's abstract)
W88-01243

APPLICATION OF IFG'S INSTREAM WATER TEMPERATURE MODEL IN THE UPPER COLORADO RIVER,
Soil Conservation Service, Fort Collins, CO.
For primary bibliographic entry see Field 2E.
W88-01248

APPLICATION OF STATISTICAL LOW FLOW ANALYSIS AS A BASIS FOR WATER QUALITY PLANNING,
Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.
For primary bibliographic entry see Field 2A.
W88-01249

NEW LOOK AT FORECASTING NATURAL PROCESSES,
Battelle Pacific Northwest Labs., Richland, WA.
G. M. Petrie.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 303-307, 3 fig, 2 ref.

Descriptors: *Hydrometeorology, *Path of pollutants, *Statistical methods, *Forecasting, *Model studies, *Waste disposal, Natural processes, Geohydrology, Long-term planning.

In an effort to aid the Department of Energy in the identification and characterization of future natural processes which may degrade the performance of a mined repository for high-level nuclear waste, a stochastic/deterministic computer model was developed for application to specific sites. This model was designed to consider long time periods over which relatively slow geologic processes can be of importance. Evaluation of the results of the first analyses suggests that this technique gives useful insight into identifying and characterizing the important processes, and appears to be particularly useful in characterizing synergistic effects. Moreover, analysis of the results suggests that applying the same technique, using a shorter time scale, to water management would be rewarding. Some of the suggested advantages of such a new application of existing technology include: (1) early detection of errors in either the data or conceptual model; (2) quantification of the probabilities for the timing and magnitude of future natural events; (3) simulation of synergistic interactions; (4) quantification of uncertainty through the use of probability density functions in a manner that is relatively easy for non-specialists to understand; (5) exchange of information among technical disciplines and across political boundaries; (6) clear separation of the effects of changes in regulations; and (7) clear separation of objective and subjective inputs. (See also W88-01203) (Author's abstract)
W88-01251

AGRICULTURE EXPANSION PLANNING: INCORPORATING WATER REUSE,
Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.
For primary bibliographic entry see Field 3C.
W88-01252

CLIMATIC VARIABILITY AND HYDROLOGIC PROCESSES: AN ASSESSMENT FOR THE SOUTHWESTERN UNITED STATES,
Arizona Univ., Tucson. Lab. of Tree-Ring Research.
For primary bibliographic entry see Field 2A.
W88-01253

MEASURING DROUGHT SEVERITY AND ASSESSING IMPACT,
Nebraska Univ.-Lincoln. Center for Agricultural Meteorology and Climatology.
For primary bibliographic entry see Field 2A.
W88-01256

DEVELOPMENT OF A SURFACE WATER SUPPLY INDEX - A DROUGHT SEVERITY INDICATOR FOR COLORADO,
Colorado Div. of Water Resources, Denver.
For primary bibliographic entry see Field 2E.
W88-01257

TRANSBORDER SALINITY AND DROUGHT MANAGEMENT: U.S./MEXICO UNRESOLVED ISSUES,
Colorado Commission on Higher Education, Denver.
For primary bibliographic entry see Field 6E.
W88-01258

SPATIAL CHARACTERISTICS OF SEVERE DROUGHT IN THE SACRAMENTO RIVER BASIN,
California Univ., Davis. Dept. of Geography.
For primary bibliographic entry see Field 2E.
W88-01260

SCALE PROBLEMS IN THE SYNTHESIS OF MULTI-SITE PRECIPITATION,
For primary bibliographic entry see Field 2B.
W88-01262

FLOOD FREQUENCY ANALYSIS WITH DETECTION AND MODIFICATION OF OUTLIERS,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 2E.
W88-01288

DECISION SUPPORT MODEL SYSTEM FOR THE ANALYSIS OF REGIONAL WATER POLICIES IN AN OPEN-PIT LIGNITE MINING AREA OF THE GDR,
International Inst. for Applied Systems Analysis, Laxenburg (Austria).
For primary bibliographic entry see Field 6D.
W88-01451

6B. Evaluation Process

POINT/NONPOINT SOURCE TRADING PROGRAM FOR DILLON RESERVOIR AND PLANNED EXTENSIONS FOR OTHER AREAS,
Northwest Colorado Council of Governments, Frisco.
For primary bibliographic entry see Field 5G.
W88-01163

ECONOMIC IMPACT OF CLIMATE ON WATER RESOURCES MANAGEMENT,
Oklahoma Climatological Survey, Norman.
For primary bibliographic entry see Field 6C.
W88-01238

POSSIBLE USES OF LONG-RANGE WEATHER OUTLOOKS IN WATER RESOURCES,
Illinois State Water Survey Div., Champaign.
S. A. Changnon.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 231-234, 3 tab, 5 ref.

Descriptors: *Hydrometeorology, *Long-term planning, *Weather, *Water resources management, *Climates, Precipitation, Water supply, Weather patterns, Reservoirs, Water use.

A series of world climate aberrations that began in the 1970's led to considerable concern over climate and its possible changes (new trends and greater fluctuations). A part of this concern developed because the world, with ever increasing population, has become more sensitive to droughts, floods, and other extremes of weather that comprise climate. This concern led to the recognition that long-range weather outlooks, referred to as those for conditions 1 to 60 months ahead, had enormous utility in the management of water, agricultural, and energy resources. The need for such forecasts has led to intensive research of physical and statistical methods. THose methods available now produce predictions with accuracies promising utility for some water management endeavors. The greatest success so far has come from the statistically based methods. This has been possible because of relatively long climatic records and large computers able to handle large volumes of data and complex statistical analyses. Major areas of application of climate outlooks in water resources include: (1) operations of water management systems (river basins, reservoirs, urban water treatment systems, groundwater recharge, etc.); (2) scheduling of water supply activities (irrigation, structural renovations, etc.); and (3) anticipation of extremes. The needs for predictions range from weeks to years ahead. For example, various reservoir operations can be benefitted by 2-week rain predictions and others by predictions of rain trends over the next 2 years. Predictions correct to the nearest 6 cm are needed in scheduling reservoir releases, but instream flow needs require only a prediction of the relative future normalcy (above, near, or below normal). This paper addresses the potential applications in water resources of outlooks. (See also W88-01203) (Author's abstract)
W88-01239

ECONOMIC GAINS FROM PROBABILISTIC TEMPERATURE FORECASTS,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W88-01243

NEW LOOK AT FORECASTING NATURAL PROCESSES,
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 6A.
W88-01251

ECONOMIC VIABILITY OF WEATHER MODIFICATION WATER PROJECTS,
Bureau of Reclamation, Washington, DC. Atmospheric Resources Management.
For primary bibliographic entry see Field 3B.
W88-01268

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

FUNDING NONPOINT CONTROL PROJECTS IN MISSOURI,
Missouri Dept. of Natural Resources, Jefferson City.
For primary bibliographic entry see Field 5G.
W88-01094

NONPOINT SOURCE POLLUTION CONTROL FUNDING FOR LAKE RESTORATION: A CASE STUDY AT CARLISLE LAKE,
Washington State Univ., Pullman. Environmental Engineering Dept.
For primary bibliographic entry see Field 5G.
W88-01108

ECONOMICS: NONPOINT SOURCE POLLUTION IMPACTS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
S. S. Batie.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 229-231, 1 tab, 4 ref.

Descriptors: *Economic aspects, *Nonpoint pollution sources, *Water pollution effects, *Water quality management, Costs, Public investment, Economic analysis, Water quality control.

Too often economics is viewed as relating only to the private finances of individuals. With this narrow view, the economics of nonpoint source pollution is perceived as identifying the costs to private citizens (for example, farmers) of controlling nonpoint source pollution problems. A more sophisticated definition of economics addresses the costs and benefits of actions to the general public as well as to the private citizen. An even more sophisticated definition, however, recognizes that economics is concerned with society's values and the role of the public sector in shaping and reflecting these values. This broad definition of economics incorporates, as legitimate concerns of the science, the design of institutions, the evolution and distribution of property rights to resources, and the role of government in reflecting emerging societal values. The broad definition of economics is used here to focus on the costs of nonpoint pollution - both the costs of 'doing something' and the costs of 'doing nothing' about nonpoint pollution. This discussion is then related to alternative institutional designs for controlling nonpoint source pollution impacts. (See also W88-01083) (Lantz-PTT)
W88-01125

ECONOMICS OF NONPOINT SOURCE POLLUTION CONTROL: LAKE TAHOE, CALIFORNIA/NEVADA,
Tahoe Regional Planning Agency, South Lake Tahoe, CA. Long Range Planning Div.
D. S. Ziegler.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 232-233.

Descriptors: *Economic aspects, *Nonpoint pollution sources, *Lake Tahoe, *California, *Nevada, *Water pollution control, *Water quality control, Water quality management, Regional planning, Public investments.

Lake Tahoe is a natural resource of exceptional quality - 'The Jewel of the Sierra'. But nonpoint source pollution control measures are necessary to protect its famous water quality. These nonpoint source controls will have a beneficial effect on the regional economy over the long run. Economic impacts on local government and individual property owners should be minor, assuming that they share the burden of capital improvements. Utility districts that finance their operations with connection fees will be affected to some degree by growth management policies. (See also W88-01083) (Lantz-PTT)
W88-01126

CONTROLLING AGRICULTURAL RUNOFF: GOVERNMENT'S PERSPECTIVE,
Economic Research Service, Washington, DC.
R. S. Magleby, and C. E. Young.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 234-236, 3 tab.

Descriptors: *Agricultural runoff, *Economic aspects, *Water quality control, *Water pollution control, *Idaho, *Illinois, *Vermont, Public policy, Costs, Cost-benefit analysis, Nonpoint pollution sources, Water quality management.

A case is made for greater consideration by government, and others, of economic benefits and costs in making decisions of nonpoint pollution sources (NPS) pollution control. This is done by presenting some results of the economic evaluation of the Rural Clean Water Program (RCWP) and using these to illustrate high priority points. The experimental Rural Clean Water Program was initiated in 1980 to demonstrate the effectiveness of an agricultural nonpoint source program. Some $60 million was allocated to 21 projects. Five of these received additional allocations to permit comprehensive monitoring and evaluation. These projects are: the Idaho Rock Creek Project, the Illinois Highland Silver Lake Project, the Vermont St. Albans Bay Project, the Pennsylvania Conestoga Headwaters Projects, and the South Dakota Oakwood Lakes-Poinsett Project. The comprehensive monitoring and evaluation studies include both water quality and economic components. The economic evaluations for the Idaho, Illinois, and Vermont projects are the most complete to date, so the discussion of results concentrates on these three. The preliminary results of the three projects allow some implications to be drawn regarding priorities for allocating public resources and determining actions to take on nonpoint source pollution control. These implications are: (1) Levels of pollution per se are not a good indication of the economic damages being caused by NPS pollution, or of the likely benefits to the public from its control; (2) Economic benefits of NPS pollution control can vary dramatically among areas; (3) Some anticipated benefits may actually be negligible; (4) Costs of controlling NPS pollution can differ greatly among areas, and also within an area, depending on the measures used; and (5) Benefit/cost ratios, which bring together both the benefit and cost sides, are the best indication of where government and the public will get the most for money spent. (See also W88-01083) (Lantz-PTT)
W88-01127

OPTIMIZING POINT/NONPOINT SOURCE TRADEOFF IN THE HOLSTON RIVER NEAR KINGSPORT, TENNESSEE,
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 5G.
W88-01164

ECONOMIC IMPACT OF CLIMATE ON WATER RESOURCES MANAGEMENT,
Oklahoma Climatological Survey, Norman.
A. Eddy.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 225-229, 8 fig, 1 tab, 3 ref.

Descriptors: *Hydrometeorology, *Economic aspects, *Economic impact, *Climates, *Water resources management, Storms, Water supply, Costs, Rainfall, Streamflow, Water use.

The economic well being of our country has become so critically dependent upon its water resources that expected variability in rainfall patterns could impose stresses leading to major social and economic dislocations. Summertime convective storms deliver most of the High Plains' surface water supply both directly to crops and indirectly by way of stockponds, reservoirs, and streams to all water requiring sectors of the economy. What is the expectation and the variability of this nondepletable resource. The problem of providing a user-oriented climatology of these convective storms has two interlinked aspects. The first is to find out exactly how the user-activities are climate sensitive and the second is to obtain an adequate sample of data to make the use of the required climatology cost effective. From a scientific point of view, no optimal sampling system can be designed nor can the 'best' data processing (climatology) be accomplished until the users' value systems are known. Currently, Oklahoma daily rainfall, streamflow (discharge) and lake level historical data sets to assess surface water availability is being analyzed; and the agriculture, municipal and industrial sectors as users which turn water into goods, services and hence dollars is being examined. One of the results illustrates the variability of the Gross State Product of Oklahoma as a function of the rainfall variability across the state. (See also W88-01203) (Author's abstract)
W88-01238

6D. Water Demand

ECONOMIC GAINS FROM PROBABILISTIC TEMPERATURE FORECASTS,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W88-01243

CLIMATIC VARIABILITY AND HYDROLOGIC PROCESSES: AN ASSESSMENT FOR THE SOUTHWESTERN UNITED STATES,
Arizona Univ., Tucson. Lab. of Tree-Ring Research.
For primary bibliographic entry see Field 2A.
W88-01253

TRANSBORDER SALINITY AND DROUGHT MANAGEMENT: U.S./MEXICO UNRESOLVED ISSUES,
Colorado Commission on Higher Education, Denver.
For primary bibliographic entry see Field 6E.
W88-01258

USE OF HYDROMETEOROLOGICAL DATA IN DROUGHT MANAGEMENT: POTOMAC RIVER BASIN CASE STUDY,
Interstate Commisson the Potomac River Basin, Rockville, MD. Cooperative Water Supply Operations on the Potomac River.
For primary bibliographic entry see Field 2E.
W88-01259

WATER BALANCE MODEL OF THE TRANSDANUBIAN MOUNTAIN RANGE IN HUNGARY FOR MINING PURPOSES,
Hungarian Aluminium Corp., Budapest.
For primary bibliographic entry see Field 2F.
W88-01445

DECISION SUPPORT MODEL SYSTEM FOR THE ANALYSIS OF REGIONAL WATER POLICIES IN AN OPEN-PIT LIGNITE MINING AREA OF THE GDR,
International Inst. for Applied Systems Analysis, Laxenburg (Austria).
S. Kaden, L. Luckner, D. Peukert, and K. Tiemer.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 503-514, 3 fig, 2 tab, 8 ref.

Descriptors: *Water allocation, *Water use, *Model studies, *Mathematical models, *Water policy, Lignite mining, Lignite, East Germany, Water management, Resources management, Mathematical equations, Model testing.

A decision support model system for the analysis of regional water policies in open-pit lignite mining areas was developed in compliance with the International Institute for Applied Systems Analysis Standards. It is verified and implemented for a test region in the Lusatian Lignite District of the German Democratic Republic. One of the major components, a planning model for multi-criteria analysis, is described. The underlying mathematical model is outlined for the test area, depicting examples of its major submodels as indicators of systems development. The solution procedure, the structure of the model system, and its practical application are explained. (See also W88-01408) (Author's abstract)
W88-01451

GAME THEORETICAL MODEL FOR THE EXAMINATION OF THE MUTUAL EFFECT OF MINING AND ENVIRONMENTAL CONTROL,
Central Inst. for Mining Development, Budapest (Hungary).
S. Molnar, and F. Szidarovszky.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September

1985. p 523-530, 5 tab, 5 ref.

Descriptors: *Water allocation, *Water users, *Coal mining, *Environmental protection, *Water supply, *Model studies, Data interpretation, Hungary, Municipal water, Industrial water, Aquifers, Thermal water, Mathematical models, Mathematical equations, Case studies.

Large-scale coal mining operations are planned for the Transdanubian Mountains, Hungary. However, the mineral resources are located below the karstic aquifer water which supplies the municipal and industrial water for the region. In addition, the lowering of the aquifer water level required by mining affects the environment because the natural recharge of the thermal waters of Budapest and Heviz originates in this karstic aquifer. A solution optimal for one of these objectives is usually far from optimal for the other two. Therefore, the optimization problem can be considered a three-objective problem with three decision-makers since mining, water supply, and environmental protection come under the jurisdiction of separate authorities. A conjunctive analysis of regional mineral resource exploitation, municipal water supply and environmental protection is provided by a multiobjective programming model which demonstrates how an aquifer management problem can be solved by the theory and methods of noncooperative games in which the decision-makers are the 'players' and the objective functions are the 'payoff' functions. The mathematical model and numerical results for a case study of a groundwater system in Hungary are presented. (See also W88-01408) (Wood-PTT)
W88-01453

6E. Water Law and Institutions

CASE STUDIES INVOLVING THE TREATMENT OF HAZARDOUS SUBSTANCES UNDER THE SUPERFUND REMEDIAL ACTION PROGRAM,
Environmental Protection Agency, Washington, DC. Remedial Response Control.
For primary bibliographic entry see Field 5D.
W88-00995

THERMAL DESTRUCTION OF IGNITABLE HAZARDOUS WASTE. A CASE STUDY IN REGULATORY INTERPRETATION,
Weston (Roy F.), Inc., West Chester, PA.
For primary bibliographic entry see Field 5E.
W88-01009

LIABILITY FOR PERSONAL INJURY DAMAGES: A NEW PROBLEM FOR INDUSTRIAL WASTE GENERATORS,
Brown and Caldwell, Pasadena, CA.
H. Zeitzew.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 453-458.

Descriptors: *Waste disposal, *Legal aspects, *Liability, *Industrial wastes, *Personal injury, *Hazardous wastes, *Torts, Safety, Toxicity, Law enforcement.

A toxic substance is one that can cause injury or death as a result of its chemical action. Toxic tort law is a relatively new branch of civil law which deals with injuries to the person that result from exposures to toxic substances including drugs, chemicals, pesticides, and hazardous wastes. The injuries that result from such exposures are often latent and may not manifest themselves until many years after the exposures have occurred. Exposures to toxic substances are usually either workplace related, drug related, or environmental. Conventional tort law principles are effective in dealing with a sudden event or with an acute disease, where the cause of the injury is comparatively easy to understand and to prove. However, exposure to a toxic substance could result in a chronic or progressive disease or result in a non-sudden event for which cause and effect may not be readily demonstrated unless the exposure was workplace related or drug related. As a result, conventional tort law principles are often inappropriate when applied to environmental toxic torts and may actually serve as barriers to recovery by plaintiffs who allege injuries. Under present tort law principles, generators of hazardous wastes have been enjoying virtual immunity from liability for personal injury damages that may result from the willful or negligent release of toxic substances. That immunity from liability has been a significant factor in perpetuating the low cost of land disposal. However, immunity from liability may soon be a thing of the past. Three of the principal barriers to recovery for personal injury damages under existing tort law principles are: (1) obstacles imposed by the statute of limitations in states which use the 'exposure rule' rather than the 'discovery rule'; (2) requirements with respect to proof of causation in order to establish a defendant's liability; and (3) requirements for proving and quantifying damages. (See also W88-00963) (Lantz-PTT)
W88-01010

KEYNOTE ADDRESS: THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, LIABILITY, AND COMPENSATION ACT OF 1980,
Baker and Hostetler, Inc., Cleveland, OH.
J. H. Russell.
IN: Proceedings of the 39th Industrial Waste Conference, May 8-10, 1984, Purdue University, West Lafayette, Indiana. Butterworth Publishers, Boston. 1985. p 463-467.

Descriptors: *Legal aspects, *Legislation, *Comprehensive Environmental Response, *CERLCA, *Superfund, *Statutes, Liability, and Compensation Act, Liability, Regulations.

CERCLA, or the Comprehensive Environmental Response, Liability, and Compensation Act of 1980, empowers EPA to: target a waste site, do a site assessment, determine what is needed and cleanup the site, and then look to the generators of the waste found at the site for reimbursement to the 'Superfund', or 'the Fund.' The fund of 1.6 billion dollars was created by Congress to pay for the costs of cleanup, which are known as remediation costs, remedial action or response costs. Although there are four statutory acts for which one is strictly liable for the cost of remediation and response, only three are of immediate interest. If one: owns or operates a hazardous waste management facility, arranges for the disposal of hazardous waste, or accepts such waste, one is strictly liable for Agency response costs that are not inconsistent with the National Contingency Plan. There must also be a release or threatened release - leakage or spillage from the drums or containers. There are four statutory defenses: an act of God, an act of war, an act of a third party not your agent, or some combination of these. These are not much help. But they were not intended to be. Congress intended that one must be strictly liable for the costs of response. 'Strictly liable' means that the negligence standard of care - what the reasonable person would do - doesn't apply. It doesn't matter whether you knew, or didn't know, or should have known. This is what the CERCLA statute is about in a nutshell. Also discussed is the imminent-and-substantial endangerment provisions of statute 106, about which there are two legal issues developing in the courts in CERCLA law today; one is joint and several liability, and the other is apportionment. (See also W88-00963) (Lantz-PTT)
W88-01012

OVERVIEW OF THE NATIONAL NONPOINT SOURCE POLICY,
Synectics Group, Inc., Washington, DC.
A. Marasco, C. Gesalman, V. Daub, C. Myers, and J. Meek.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 47-50, append.

Descriptors: *Nonpoint pollution sources, *Regulations, *Public policy, *Water quality control, *Water pollution control, *Environmental Protection Agency, Legal aspects, State jurisdiction, Federal jurisdiction.

A task force composed of representatives of Federal, State, interstate, and local agencies and several private groups recently completed work on a new national nonpoint source policy. This policy will provide a framework for all nonpoint source programs. It sets out what activities are to be undertaken by each group. Among other things, the policy speaks to development of implementation strategies by the many agencies involved in nonpoint source management. In fact, the U.S. Environmental Protection Agency (EPA), the other Federal agencies involved in the task force, and several States have already developed implementation strategies. Key points from the policy and highlights of the various strategies are profiled here, and the most critical aspects for success are the central focus. The paper also describes the evaluation framework EPA plans to use in assessing State program implementation strategies. (See also W88-01083) (Author's abstract)
W88-01089

INTERGOVERNMENTAL COORDINATION: FEAST OR FAMINE,
South Brevard Water Authority, Melbourne, FL.
R. J. Massarelli.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 51-54, 2 fig, 1 tab.

Descriptors: *Water resources development, *Florida, *Lake Washington, *Interagency task force, *Saint Johns River, *Nonpoint pollution sources, Lakes, Water supply, Water quality control, Agriculture, Regulations.

Lake Washington, on Florida's east coast, is the sole water supply for over 100,000 people in south Brevard County. This lake is one of a chain of lakes on the St. Johns River. Water quality problems in Lake Washington, as well as the St. Johns River, have been described as natural problems aggravated by man. All of the man-induced water quality problems are the result of nonpoint sources. Historically, diking and draining of the St. Johns River marsh and continued agricultural drainage has been the principal nonpoint source pollution. During the last 15 to 20 years, urban drainage has been introduced into the lake. An interagency task for ce was formed to protect and improve the water quality of Lake Washington. This task force included the major regulatory agencies, water resource managers, and water users of Lake Washington. The task force's effectiveness was governed by: (1) problem definition, (2) agency statutory power, (3) agency program priority, and (4) interaction by policy level individuals. (See also W88-01083) (Author's abstract)
W88-01090

BASIC LEGAL ISSUES,
Environmental Defense Fund, New York.
J. T. B. Tripp.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 35-59.

Descriptors: *Legal aspects, *Water quality control, *Nonpoint pollution sources, Laws, Regulations, Highways, Runoff, Legislation, Agriculture.

Nonpoint source water pollution is thought difficult to control because it derives from diffuse sources over a broad area. Many forms of nonpoint source pollution derive, however, from inappropriate use of land or water resources which are subject to regulation through Federal and State wetland protection laws, such as the Clean Water Act section 404 Program, local government zoning powers, and other local, State or Federal laws which contribute directly or indirectly to nonpoint source pollution. With respect to urban or highway runoff, vigorous enforcement of Clean Air Act programs relating to mobile and stationary sources may result in significant reduction of im-

pacts of metals, organics, and acid rain. Non-enforceable Best Management Plans are virtually useless at controlling nonpoint source pollution. For some existing nonpoint source pollution, such as agricultural soil, nutrient and pesticide runoff, cost-effective economic investments must be identified which control such pollution through alternative use of waste resources and find the institutional mechanisms to facilitate those investments. (See also W88-01083) (Author's abstract)
W88-01091

COMPELLING ON-THE-GROUND IMPLEMENTATION OF MEASURES TO CONTROL NONPOINT SOURCE POLLUTION,
National Audubon Society, Washington, DC.
For primary bibliographic entry see Field 5G.
W88-01092

CONTROLLING NONPOINT SOURCES OF POLLUTION - THE FEDERAL LEGAL FRAMEWORK AND THE ALTERNATIVE OF NONFEDERAL ACTION,
Department of the Interior, Washington, DC.
For primary bibliographic entry see Field 5G.
W88-01093

STATE OF MARYLAND NONPOINT SOURCE CONTROL IMPLEMENTATION PROGRAM,
Maryland Dept. of Health and Mental Hygiene, Baltimore. Office of Environmental Programs.
For primary bibliographic entry see Field 5G.
W88-01095

WISCONSIN NONPOINT SOURCE PROGRAM,
Wisconsin Dept. of Natural Resources, Madison.
For primary bibliographic entry see Field 5G.
W88-01096

BRIDGING THE GAP BETWEEN WATER QUALITY AND NONPOINT SOURCE ACTIVITIES: A CONTINUUM OF INSTITUTIONAL ARRANGEMENTS,
Environmental Protection Agency, Boston, MA.
B. Hague.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 79-84, 1 fig, 12 ref.

Descriptors: *Nonpoint pollution sources, *Water quality control, *Institutions, Water quality management, State jurisdiction, Interagency cooperation, Management planning, New England.

Successful nonpoint source control implementation requires devising institutional/legal arrangements to draw formally the various interests and agencies responsible for Best Management Practices (BMP's) into the water quality management process; yet, at the same time, formalize the role of the State Water Quality Management (WQM) agencies. EPA and the New England States have established an array of mechanisms by which State WQM agencies formally involve the State forester, timber industry, construction industry, and agricultural interests in activities ranging from technical assistance on BMP certification and plan review to limited inspection. Corresponding mechanisms for backup enforcement by the State WQM agency, Attorney General, and EPA vary. This presentation outlines and evaluates the experience with these mechanisms over the past 5 years, suggesting improvements, refinements, or new mechanisms for the future. The evaluation covers a continuum of measures from the voluntary to backup enforcement, and from private to public responsibilities. (See also W88-01083) (Author's abstract)
W88-01097

UTAH AGRICULTURE RESOURCE DEVELOPMENT LOAN PROGRAM,
Utah Dept. of Agriculture, Salt Lake City.
J. A. Paraskeva.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 85-87.

Descriptors: *Water conservation, *Utah, *Loans, *Legislation, *Agriculture, Soil conservation, Economic aspects, Utah Agricultural Research Development Loan, Water quality control, Conservation, Costa.

In 1983, the Utah Legislature provided $2.4 million for soil and water conservation practices to the Utah Agricultural Research Development Loan (ARDL) program. Loans are made at a 3% interest rate with a one-time 4% administrative fee and a maximum 12-year loan length. The Utah Soil Conservation Commission administers the program and local Soil Conservation Districts are responsible for plan approval. After 2 years of operation, over $11 million has been loaned to farmers for conservation work. The ARDL program is divided into three categories: (1) the regular ARDL program for soil and water conservation practices; (2) the watershed program for conservation and water quality practices in special targeted areas; and (3) the emergency conservation program. This program has been successful in implementing conservation practices and improving water quality in Utah. The program is a revolving fund loan and provides operators with an incentive to install practices that benefit the public at a low cost to the taxpayers. Utah is currently the only State in the Nation operating a program of this kind. (See also W88-01083) (Author's abstract)
W88-01098

COMPREHENSIVE PROTECTION FOR TWO MULTIPURPOSE RESERVOIRS IN CENTRAL NORTH CAROLINA - EPA'S NATIONAL NONPOINT SOURCE POLICY CAN WORK,
Triangle J Council of Governments, Research Triangle Park, NC.
For primary bibliographic entry see Field 5G.
W88-01101

CHESAPEAKE BAY NONPOINT SOURCE POLLUTION,
Chesapeake Bay Liaison Office, Annapolis, MD.
For primary bibliographic entry see Field 5B.
W88-01113

NONPOINT SOURCE POLLUTION CONTROL IN SMALL BAYS OF PUGET SOUND,
Washington Dept. of Ecology, Olympia, WA. Shorelands Div.
For primary bibliographic entry see Field 5G.
W88-01115

ASSOCIATION OF STATE AND INTERSTATE WATER POLLUTION CONTROL ADMINISTRATORS,
Association of State and Interstate Water Pollution Control Administrators, Washington, DC.
R. J. Savage, and L. Eichmiller.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 227-228.

Descriptors: *Association of State and Interstate Water Pollution Control Administrators, *Nonpoint pollution sources, *Water quality control, Water quality management, State jurisdiction, Interagency cooperation, Funding.

The Association of State and Interstate Water Pollution Control Administrators (ASIWPCA) is confident about the future of nonpoint source pollution. However, future commitments involve the need to move from the status quo to: understanding environmental priorities; getting the facts straight; making the existing consensus advantageous; and planning strategically. The ASIWPCA position on nonpoint source pollution provides that: Water quality management plans should be the basis for implementation - that is, existing information is generally adequate; Nonpoint source pollution is primarily a State responsibility; States are moving ahead but much remains to be done; Federal funding and technical assistance are needed to promote that activity; States should be held accountable for resolving their priority water quality problems; Federal regulatory programs would not help promote nonpoint source pollution control; and, Nonpoint source should be an integral part of the Section 106 program. (See also W88-01083) (Lantz-PTT)
W88-01124

CONTROLLING AGRICULTURAL RUNOFF: GOVERNMENT'S PERSPECTIVE,
Economic Research Service, Washington, DC.
For primary bibliographic entry see Field 6C.
W88-01127

WATERSHED WATER QUALITY PROGRAMS: LESSONS LEARNED IN ILLINOIS,
Environmental Protection Agency, Chicago, IL. Region V.
For primary bibliographic entry see Field 5G.
W88-01130

PRAIRIE ROSE LAKE RURAL CLEAN WATER PROGRAM PROJECT,
Iowa Dept. of Water, Air and Waste Management, Des Moines.
For primary bibliographic entry see Field 5G.
W88-01131

IMPLEMENTING AN URBAN NONPOINT SOURCE CONTROL STRATEGY,
Satterthwaite Associates, Inc., West Chester, PA.
For primary bibliographic entry see Field 5G.
W88-01138

URBAN STORMWATER QUALITY MANAGEMENT: THE FLORIDA EXPERIENCE,
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 5G.
W88-01139

PROBLEMS AND PROGRESS IN URBAN SOIL EROSION AND SEDIMENTATION CONTROL: A BICOUNTY PERSPECTIVE,
Lake County Dept. of Planning, Zoning and Environmental Quality, Waukegan, IL.
P. G. Thum, and G. A. Paulson.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 295-299, 1 fig, 2 tab, 23 ref.

Descriptors: *Water pollution control, *Erosion control, *Urban ares, *Soil erosion, *Sedimentation control, *Water management, *Fox River, *Chain O'Lakes, *Illinois, *Nonpoint pollution sources, Sedimentation, Interagency cooperation.

Controlling urban-related soil erosion and sedimentation problems in northeastern Illinois requires involvement by all water resource user groups in the decision making and enforcement process. The Fox River-Chain O'Lakes region in Lake and McHenry Counties. Illinois, suffers from serious sedimentation problems caused partly by construction site soil erosion within the watershed. Despite having the authority to control such nonpoint pollution problems, many municipalities lack truly comprehensive ordinances or the means to effectively enforce such regulations. Anticipated new development in the watershed may worsen already existing sedimentation problems. Both counties recognize their common interest in the assets and problems provided by the Fox River-Chain O'Lakes. Lake County has worked extensively in nonpoint pollution since the 1970's. McHenry County, on the other hand, has not yet experienced the development pressure associated with close proximity to the Chicago metropolitan area. Currently, McHenry County Defenders, a private citizens advocate group, is spearheading a public education effort to prevent further damage to the Fox River-Chain O'Lakes by soil erosion and sedimentation from construction sites. Cooperative work between Lake County and the Defenders intends

to address this nonpoint pollution concern across the bicounty jurisdiction. (See also W88-01083) (Author's abstract)
W88-01140

NATIONAL PERSPECTIVE ON ENVIRONMENTAL CONSTRAINTS TO HYDROELECTRIC DEVELOPMENT,
Oak Ridge National Lab., TN. Environmental Sciences Div.
S. G. Hildebrand, M. J. Sale, G. F. Cada, and J. M. Loar.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 301-303, 12 ref.

Descriptors: *Environmental effects, *Hydroelectric power, *Water resources development, *Water quality, Hydroelectric plants, Dissolved oxygen, Tailwater, Fisheries, River basins, Ecological effects.

The U.S. Department of Energy (DOE) initiated a hydropower development program in 1977 to promote small-scale (< or = MW) hydroelectric projects across the country. Consistent with DOE's support of research on environmental aspects of energy production, it was recognized that analysis of potential environmental constraints should be an integral part of the DOE program. The Environmental Sciences Division of Oak Ridge National Laboratory implemented studies on the environmental effects of hydropower development in 1978 in support of the DOE effort. Problems associated with the concentration of dissolved oxygen in tailwaters below dams and instream flow requirements for fisheries are analyzed. The need for, and technical challenges related to, assessment of the environmental effects of multiple-project developments in river basins are discussed. Although the focus of the DOE program is on small-scale hydroelectric development, the issues discussed are applicable to large-scale facilities as well. (See also W88-01083) (Lantz-PTT)
W88-01141

IMPLEMENTING THE PUBLIC/PRIVATE NONPOINT SOURCE MANAGEMENT PARTNERSHIP: A STATE FORESTRY PERSPECTIVE,
Oklahoma State Dept. of Agriculture, Oklahoma City. Forestry Div.
For primary bibliographic entry see Field 5G.
W88-01144

NONCOAL MINERAL MINING AND RECLAMATION (CURRENT AND ABANDONED OPERATIONS) IN THE TENNESSEE RIVER BASIN,
Tennessee Valley Authority, Norris.
For primary bibliographic entry see Field 5G.
W88-01146

REGULATING NONPOINT SOURCES OF POLLUTION FROM TIMBER HARVESTING - A CASE HISTORY OF THE CALIFORNIA EXPERIENCE,
Humboldt State Univ., Arcata, CA.
For primary bibliographic entry see Field 5G.
W88-01160

POINT/NONPOINT SOURCE TRADING PROGRAM FOR DILLON RESERVOIR AND PLANNED EXTENSIONS FOR OTHER AREAS,
Northwest Colorado Council of Governments, Frisco.
For primary bibliographic entry see Field 5G.
W88-01163

BACTERIAL WATER QUALITY AND SHELLFISH HARVESTING,
Oregon State Dept. of Environmental Quality, Portland.
For primary bibliographic entry see Field 5G.
W88-01171

TRANSBORDER SALINITY AND DROUGHT MANAGEMENT: U.S./MEXICO UNRESOLVED ISSUES,
Colorado Commission on Higher Education, Denver.
R. L. Eldridge.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 343-346, 3 ref.

Descriptors: *Hydrometeorology, *Reservoir operation, *Water management, *Salinity, *Drought, *International agreements, *United States, *Mexico, *Colorado River, Treaties, Water quality, Water supply.

The U.S. government has guaranteed the quantity and the quality of the water delivered at the border to Mexico in the Colorado River. The history and substance of these commitments are briefly reviewed. The unresolved issues of salinity control and drought response are described. Particular attention is given to how the salt loading problem is defined, and to the lack of definity of 'extraordinary drought.' The conclusion is that a Salinity Control and Drought Response Compact is needed among the states of the Colorado River Basin. (See also W88-01203) (Author's abstract)
W88-01258

FEDERAL/STATE COOPERATIVE WEATHER MODIFICATION PROGRAM,
National Oceanic and Atmospheric Administration, Boulder, CO. Weather Modification Program Office.
For primary bibliographic entry see Field 3B.
W88-01265

STATE PERSPECTIVE ON WEATHER MODIFICATION ACTIVITIES,
Colorado Dept. of Natural Resources, Denver. Weather Modification Program.
For primary bibliographic entry see Field 3B.
W88-01269

INTERNATIONAL ASPECTS OF ACID DEPOSITION,
North Carolina State Univ., Raleigh. School of Forest Resources.
For primary bibliographic entry see Field 5C.
W88-01272

U.S. NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM,
National Acid Precipitation Assessment Program, Washington, DC.
For primary bibliographic entry see Field 5C.
W88-01273

IMPACT OF THE RESOURCE CONSERVATION AND RECOVERY ACT ON THE DESIGN OF HAZARDOUS WASTE INCINERATORS,
IT Enviroscience, Inc., Knoxville, TN.
J. N. Clark, and J. J. Cudahy.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 93-108, 7 tab, 17 ref.

Descriptors: *Waste treatment, *Resource Conservation and Recovery Act, *Detoxification, *Hazardous wastes, *Incineration, *Wastewater treatment, *Path of pollutants, Legislation, Waste characteristics, Landfills, Chemical treatment, Biological treatment, Injection.

Passage of the Resource Conservation and Recovery Act (RCRA) in 1976 ushered in a new era of hazardous waste regulation. The U.S. Environmental Protection Agency (EPA) currently estimates that 67,000 generating facilities, handling some 43 million wet metric tons of hazardous waste (HW) will be regulated in 1981. Approximately 10-20% of this hazardous waste is being incinerated in about 850 industrial and commercial HW incinerators. Between 1981 and 1985, possibly 50-100 new industrial and commercial HW incinerators may need to be designed and installed to meet the disposal pressure caused by RCRA. Subtitle C of RCRA requires 'cradle-to-grave' accountability for HW materials. Wastes will be tracked and regulated from their generation point through storage, transportation, and final treatment and/or disposal. One of the key Subtitle C sections is Section 3004, 'Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities.' This section includes standards for treatment alternatives, which include incineration, landfill, surface impoundments, land-farming, chemical, physical and biological treatment, and underground injection. This chapter discusses the impact of RCRA SEction 3004 on the design of industrial and contractor HW incineration systems. (See also W88-01297) (Lantz-PTT)
W88-01301

FEDERAL POLYCHLORINATED BIPHENYL REGULATIONS,
Environmental Protection Agency, Washington, DC. Office of Pesticides and Toxic Substances.
M. Velie, and G. Kuntz.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 121-130, 4 ref.

Descriptors: *Waste treatment, *Waste disposal, *Hazardous wastes, *Toxic wastes, *Detoxification, *Regulations, *Polychlorinated biphenyls, *Legislation, *Water quality control, Environmental Protection Agency, Interagency cooperation, Environmental effects, Electrical equipment, Water quality standards, Aroclor, Federal Water Pollution Control Act, Food and Drug Administration, Toxic Substances Control Act.

Since the mid-1960's polychlorinated biphenyls (PCB) have been found widely distributed in low concentrations throughout the United States. In 1969, the Council on Environmental Quality (CEQ) was formed; and in 1970, the U.S. Environmental Protection Agency (EPA). Both began work on the PCB problem. CEQ was the catalyst in the formation of a federal interagency task force to coordinate the federal PCB effort. In May 1972 the task force issued a report concluding that PCB contamination was ubiquitous and represented an unquantified but undisputable hazard, and that the use of PCB should be restricted to essential applications that involve minimal direct human exposure. Once this report was issued, programs aimed at correcting the PCB problem were begun. In 1971 Monsanto, the sole domestic commercial producer of PCB, voluntarily restricted sales of PCB to 'closed-system uses,' thereby limiting sales to manufacturers of transformers and capacitors. Monsanto also introduced what it felt was a less toxic PCB mixture, Aroclor 1016. The EPA recommended raising water quality standards to reduce PCB levels to less than 0.01 ppb. In February 1973 the Organization for European Community Development (OECD) issued a directive that recommended limiting the worldwide use of PCB. EPA designated PCB as toxic substances and set a national effluent standard pursuant to Section 307(a) of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500). In 1973 the Food and Drug Administration (FDA) published regulations limiting the use of PCB in food and feed facilities and establishing temporary tolerances for PCB levels in many food and feed items. In February 1977 EPA banned PCB discharges into waterways by capacitor and transformer manufacturers, and finally in 1976 the Toxic Substances Control Act (TSCA) (PL 94-469) was passed by Congress, requiring regulation of PCB. (See also W88-01297) (Lantz-PTT)
W88-01303

SELECTED LEGAL ASPECTS OF A DIOXIN DETOXICATION PROJECT,
Syntex Research, Inc., Palo Alto, CA.
K. A. Stormer.
IN: Detoxication of Hazardous Waste. Ann Arbor Science, Ann Arbor, MI. 1982. p 261-267.

Descriptors: *Legal aspects, *Dioxin, *Detoxification, *Cleanup operations, *Waste treatment, *Pollution treatment, Hexachlorophene, Trichlorophenol, Wastewater treatment, Sludge, Waste disposal, Organic compounds.

In the late 1960s North Eastern Pharmaceutical and Chemical Company, Inc. (NEPACCO) leased a portion of the Syntex Agribusiness Verona plant from the company that then owned it. Under this lease, NEPACCO was entirely responsible for disposing of its own wastes and trash, and agreed to operate at all times in conformity with applicable laws and regulations. NEPACCO's activities at the plant included the production of hexachlorphene. One step of that manufacturing process which involved the purification of trichlorophenol (TCP), apparently produced dioxin as an unwanted by-product. Syntex Agribusiness later acquired the Verona plant subject to the existing lease with NEPACCO. NEPACCO ran into financial difficulties when hexachlorophene, its main product line, was essentially removed from the market by the Food and Drug Administration (FDA) and soon thereafter NEPACCO allowed its corporate charter to lapse. NEPACCO had evidently abandoned the tank upon its own financial collapse. The first-priority activity, from legal as well as other perspectives, was to provide additional safety precautions for the tank. A reinforced concrete dike, capable of containing the entire contents of the tank should it leak, was constructed beneath it; a building was erected over it; and a wire fence was constructed beneath it. After the area was safely secured, Syntex turned its attention to finding a suitable way to resolve the problem. The overriding consideration for Syntex in searching for and selecting a disposal method was the safety of the public, its employees and the surrounding area. At one point, the possibility of incineration at sea on the ship Vulcanus was also explored. This option met with two main obstacles: the unwillingness of state and federal authorities to allow transportation across state lines and the unwillingness of the Vulcanus to handle what it viewed as a small quantity of waste. In general, as the hazards of dioxin became more publicized, fewer and fewer consultants or contractors were willing to become involved in the disposal of this material. However, despite these difficulties, Syntex continued to search for a disposal method, and began exploring the possibility of detoxifying the NEPACCO wastes onsite. This paper further discusses the necessity for legal involvement and the lawyer's interaction with other disciplines. (See also W88-01297) (Lantz-PTT)
W88-01312

POLICY ISSUES ASSOCIATED WITH RESERVOIR RELEASES,
Tennessee Valley Authority, Knoxville.
J. S. Crossman.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 11-14, 8 ref.

Descriptors: *Public policy, *Reservoir releases, *Water quality control, *Tennessee Valley Authority, *Reservoir operation, Dissolved oxygen, Tailwaters, Costs, Water quality control.

Reservoir releases from the Tennessee Valley Authority's (TVA) dams are adversely affecting approximately 340 miles of stream during late summer, low flow conditions. The parameter of greatest concern and the one most often failing to meet State and Federal water quality criteria is dissolved oxygen (DO). Unacceptably low DO concentrations in combination with reservoir operations that leave steam beds dry for up to 45 days/yr have severely impacted tailwaters and have virtually eliminated any potential they offer. Because of changed public priorities, TVA is in the process of addressing and/or accommodating the nonstatutory demands being made on TVA's reservoir system. However, major policy questions that still need to be addressed include: (1) are reservoir releases being improved to restore beneficial uses or to develop the resource, (2) should the cost of improvements be paid by the ratepayer or taxpayer, and (3) what level of improvement should TVA strive for. (See also W88-01319) (Author's abstract)
W88-01320

TOXIC SUBSTANCES: CLEAR SCIENCE, FOGGY POLITICS,
Marine Biological Lab., Woods Hole, MA. Ecosystems Center.
For primary bibliographic entry see Field 5B.
W88-01363

TECKOMATORP, SWEDEN -- WASTE PROBLEMS FROM THE PERSPECTIVE OF A MANUFACTURING INDUSTRY,
National Swedish Environment Protection Board, Solna.
For primary bibliographic entry see Field 5B.
W88-01378

ANSWER TO ASSESSING HAZARDOUS WASTE PROBLEMS IS COOPERATION,
Occidental Chemical Co., Lathrop, CA. Environmental, Health and Safety.
For primary bibliographic entry see Field 5G.
W88-01382

RESPONSE CAPACITY -- STATE GOVERNMENT,
California Dept. of Health Services, Sacramento.
For primary bibliographic entry see Field 5G.
W88-01396

ENVIRONMENTAL ENFORCEMENT: CHANGING THE CORPORATE MIND,
Office of the Associate Attorney General, Washington, DC. Land and Natural Resources Div.
For primary bibliographic entry see Field 5E.
W88-01400

6F. Nonstructural Alternatives

UTAH AGRICULTURE RESOURCE DEVELOPMENT LOAN PROGRAM,
Utah Dept. of Agriculture, Salt Lake City.
For primary bibliographic entry see Field 6E.
W88-01098

GATLINBURG, TENNESSEE, FLASH FLOOD WARNING AND EVACUATION SYSTEM,
Tennessee Valley Authority, Knoxville. Floodplain Management Branch.
For primary bibliographic entry see Field 2E.
W88-01230

FLOOD FORECASTING/WARNING SYSTEM FOR IBADAN, NIGERIA,
Ibadan Univ. (Nigeria). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W88-01231

6G. Ecologic Impact Of Water Development

HISTORY OF THE CADDO RIVER WATERSHED,
Ouachita Baptist Univ., Arkadelphia, AR.
J. T. Greer.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 56-69, 26 ref.

Descriptors: *Caddo River, *Watersheds, *History, *Arkansas, Ouachita River, Social aspects, Water resources development.

In 1817, Stephen F. Austin and his speculating brother-in-law, attempting to strike it rich in new frontiers, selected three sites for towns in southwestern Arkansas, one of which was the spot at which the Caddo joins the Ouachita in Clark County. On November 30, 1804, William Dunbar and George Hunter passed over the Fourche des Cadaux en route to Hot Springs during the period called the pioneer naturalist phase in the history of American science. Recommended to Governor Claiborne of Louisiana by Thomas Jefferson, Dunbar and Hunter travelled the Ouachita and Caddo Rivers in order to collect, name and assemble data in the upland region of the territory newly acquired from the Spanish. In 1541, Desoto's army marched to Tula and Tanico, believed by Colonel William Fordyce to be the Caddo Gap area, and there they encountered the fierce inhabitants known as the Tula Indians. The name of the Caddo is derived from French 'Cadodaquois' of the 18th century and refers to the 'Great Chiefs' of the Kadohodacho, the Caddo Indians who may not have come into the valley proper until the late 1700's. For convenience and clarity, this paper has been divided into five sections to correspond with the five distinct lifestyles in the Caddo River region. Those categories are the archaic period, the Caddoan period, the pioneer period, the Civil War and Reconstruction period, and the period of the twentieth century. (See also W88-01056) (Lantz-PTT)
W88-01058

POPULATION DYNAMICS OF THE FISHES IN DEGRAY LAKE, ARKANSAS, DURING EPILIMNIAL AND HYPOLIMNIAL RELEASE,
For primary bibliographic entry see Field 2H.
W88-01073

ENTRAINMENT OF LARVAL FISH FROM DEGRAY LAKE, ARKANSAS, DURING EPILIMNIAL AND HYPOLIMNIAL DISCHARGES,
National Fishery Research Lab., La Crosse, WI.
For primary bibliographic entry see Field 2H.
W88-01074

NATIONAL PERSPECTIVE ON ENVIRONMENTAL CONSTRAINTS TO HYDROELECTRIC DEVELOPMENT,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 6E.
W88-01141

ENVIRONMENTAL CHANGES IN THE BLACK SEA ESTUARINE REGIONS,
Connecticut Univ., Groton. Marine Sciences Inst.
For primary bibliographic entry see Field 2L.
W88-01247

EFFECTS OF WEATHER MODIFICATION ON WATER SUPPLY FROM RESERVOIRS IN UTAH,
Law Engineering Testing Co., Englewood, CO.
For primary bibliographic entry see Field 3B.
W88-01267

POLICY ISSUES ASSOCIATED WITH RESERVOIR RELEASES,
Tennessee Valley Authority, Knoxville.
For primary bibliographic entry see Field 6E.
W88-01320

TVA RESERVOIR RELEASE IMPROVEMENTS: AN OVERVIEW,
Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.
For primary bibliographic entry see Field 5G.
W88-01321

WATER QUALITY MODELING OF REGULATED STREAMS,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5G.
W88-01324

PREDICTING EFFECTS OF REREGULATION DOWNSTREAM OF BUFORD DAM, GEORGIA,

Army Engineer Waterways Experiment Station, Vicksburg, MS.
J. M. Nestler.
IN: Proceedings: CE Workshop on Reservoir Releases. Miscellaneous Paper E-87-43, July 1987. Final Report. p 41-48, 4 fig, 1 tab, 12 ref.

Descriptors: *Reregulation, *Buford Dam, *Georgia, *Ecological effects, *Water quality control, *Chattahoochee River, *Fisheries, *Water supply, Trout, Reservoir operation.

A case-history is given of an application of the Physical Habitat Simulation (PHABSIM) system, developed by the US Fish and Wildlife Service. The application resolved potential instream flow conflicts between needs for water supply and trout habitat that would result from operation of a reregulation dam downstream of Buford DAm, Chattahoochee River, Georgia. This study documents how potential downstream conflicts between project operation and fishery concerns can be approached, formalized and resolved from both an institutional and technical standpoint. The study results indicate that multiple downstream uses of the releases from the reregulation dam can be accommodated with relatively minor changes in project operation. (See also W88-01319) (Author's abstract)
W88-01326

LAKE GREESON AND LITTLE MISSOURI RIVER MODELING STUDIES,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5G.
W88-01327

DISSOLVED OXYGEN STUDIES BELOW WALTER F. GEORGE DAM,
Army Engineer District, Mobile, AL.
For primary bibliographic entry see Field 5G.
W88-01330

AVERAGED REGIONAL LAND SUBSIDENCE EQUATIONS FOR ARTESIAN AQUIFERS,
Technion - Israel Inst. of Tech., Haifa.
J. Bear, and M. Y. Corapcioglu.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 83-107, 1 fig, 23 ref.

Descriptors: *Land subsidence, *Subsidence, *Confined aquifers, *Compaction, *Groundwater level, *Artesian aquifers, *Hydraulic models, *Model studies, Aquifers, Mathematical equations, Mathematical studies, Mathematical models, Prediction, Piezometric head, Hydraulics, Hydraulic properties.

Extensive withdrawal of groundwater is often accompanied by land subsidence, the significant settling of the land surface due to the severe reduction in pore pressure. Compaction in the vertical direction is accompanied by simultaneous horizontal displacement in the aquifer which may result in damage to engineering structures and should, therefore, be taken into consideration when developing a groundwater management plan which calls for extensive lowering of groundwater levels. Mathematical models for prediction of regional land subsidence due to pumping from aquifers are reviewed. By averaging the three-dimensional equation of water mass conservation over the thickness of an aquifer and introducing a relationship between changes in averaged piezometric head and land subsidence, assuming no horizontal displacement, a mathematical model in the form of a single equation in terms of land subsidence was obtained for pumping from an artesian aquifer. A second model for regional subsidence, which provided estimates of averaged horizontal displacements, was developed based on averaging Biot's coupled three-dimensional model. Appropriate assumptions and mathematical equations are given. (See also W88-01344) (Wood-PTT)
W88-01347

7. RESOURCES DATA

7A. Network Design

SELECTION OF STATISTICALLY APPROPRIATE COMPLIANCE SAMPLING INTERVALS,
Environmental Resources Management-North Central, Inc., Palatine, IL.
For primary bibliographic entry see Field 5G.
W88-01050

PERSPECTIVES ON NONPOINT SOURCE POLLUTION.
For primary bibliographic entry see Field 5B.
W88-01083

MONITORING AND ASSESSMENT TECHNIQUES,
Vermont Univ., Burlington. School of Natural Resources.
J. C. Clausen.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 21-24, 4 fig, 1 tab, 25 ref.

Descriptors: *Monitoring, *Water quality control, *Saint Albans Bay, *Vermont, *Water pollution sources, Case studies, Lake Champlain, Water quality management, Watersheds, Phosphorus, Bioindicators.

Excessive nutrients from a municipal point source and agricultural nonpoint sources have impaired the use of St. Albans Bay of Lake Champlain in Vermont. A comprehensive monitoring and evaluation approach is evaluating the effects of agricultural Best Management Practices (BMP's) on the quality of bay and tributary waters as part of the Rural Clean Water Program (RCWP). Monitoring techniques include edge-of-field paired watersheds, instream trend stations, bay trend sampling, and land use tracking. Related short-term studies are investigating bay circulation patterns, bay sediment phosphorus content and release, biological indicators, and the role of a wetland in treating both point and nonpoint source nutrients. Each monitoring technique and its associated assessment methods are described through project results. The comprehensive monitoring approach is designed to identify overall programmatic effects in complex watersheds. (See also W88-01083) (Author's abstract)
W88-01084

LAND USE MONITORING AND ASSESSMENT FOR NONPOINT SOURCES POLLUTION CONTROL,
Vermont Univ., Burlington. School of Natural Resources.
For primary bibliographic entry see Field 5G.
W88-01085

APPROPRIATE DESIGNS FOR DOCUMENTING WATER QUALITY IMPROVEMENTS FROM AGRICULTURAL NPS CONTROL PROGRAMS,
National Water Quality Evaluation Project.
J. Spooner, R. P. Maas, S. A. Dressing, M. D. Smolen, and F. J. Humenik.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 30-34, 3 fig, 4 ref.

Descriptors: *Water quality control, *Nonpoint pollution sources, *Agriculture, *Water quality management, Management planning, Water pollution control, *Monitoring, Optimization, Pollution load, Hydrometeorology, Land use.

Appropriate experimental designs were studied to find how Best Management Planning (BMP) implementation can affect the magnitude of pollutant concentrations or loads. This paper discusses the assumption, analysis techniques, and advantages and disadvantages of three basic experimental designs that can be used in practical terms. Monitoring above and below an implementation site is generally more useful for documenting the severity of an NPS than for documenting BMP effectiveness. Time trend designs may be helpful; however, water quality trends are a result of complex interactions between land treatment, hydrology, and meteorologic factors. Accounting for these variables will therefore greatly increase the probability of documenting water quality improvements associated with BMP's. Paired watershed designs have the greatest potential for documenting improvements from BMP implementation because of the ability to control for meteorologic and hydrologic variability. (See also W88-01083) (Author's abstract)
W88-01086

MONITORING FOR WATER QUALITY OBJECTIVES IN RESPONSE TO NONPOINT SOURCE POLLUTION,
Environmental Protection Service, Regina (Saskatchewan). Water Quality Branch.
K. W. Thomson, and G. D. Haffner.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 35-37, 7 ref.

Descriptors: *Water quality control, *Nonpoint pollution sources, *Monitoring, Herbicides, Pesticides, Agriculture, Aquatic environment, Ecosystems, Water pollution sources, Water pollution control, Toxicity.

Broad application and continued use of herbicides and pesticides have resulted in a major diffuse source input of toxic material into aquatic ecosystems. The most common present water quality assessment practices cannot account for the entry of such compounds into the environment. Unlike point source input, where levels, quantity, and consistency of loadings are known, diffuse source input must be estimated using assessment procedures. Consequently, these assessment practices are not designed for the development or site-adaptation of water quality objectives - in Canada, water quality objectives are used for determining best land use practice and providing protection to the aquatic ecosystem. These demands on environmental assessments and the subsequent development of relevant water quality objectives can only be achieved by studies that provide insight into aquatic system behavior. The different environment processes and fates that potentially regulate a compound's effect in the aquatic ecosystem emphasize the need for system behavior information. Examples from different systems illustrate the need for more comprehensive water quality assessment procedures to develop water quality objectives relevant to diffuse source inputs. (See also W88-01083) (Author's abstract)
W88-01087

USE OF BIOASSAYS TO DETERMINE POTENTIAL TOXICITY EFFECTS OF ENVIRONMENTAL POLLUTANTS,
Corvallis Environmental Research Lab., OR. Hazardous Waste and Water Branch.
S. A. Peterson, W. E. Miller, J. C. Greene, and C. A. Callahan.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 38-45, 7 fig, 3 tab, 14 ref.

Descriptors: *Bioassays, *Toxicity, *Water pollution effects, *Nonpoint pollution sources, Monitoring, Environmental effects, Lethal limits, Heavy metals, Organic compounds, Biological studies.

Nonpoint source (NPS) runoff from mining, landfills, roads, croplands, grazing lands, and forests can contain chemicals harmful to aquatic organisms. Full scale biological surveys to determine their effects are difficult and costly. Bioassays of environmental samples integrate the effects of all toxicants contained in a sample. Biological organisms are being used more frequently to identify toxicant problems and to rank-order their severity.

Group 7A—Network Design

The Corvallis Environmental Research Laboratory (CERL) has developed a multi-media (aquatic/terrestrial) bioassessment protocol to assist in the identification of toxicity potentials associated with waste disposal. Similar techniques can be used to identify NPS pollutants. The bioassay response indicators are particularly useful in identification of field-site problems where complex mixtures of pollutants might be present. Use of the bioassessment protocol reduces the initial need for extensive chemical analyses, and produces data (toxicity LC50 information) in a form more readily understood by the public than bulk chemical concentrations. The CERL protocol has been used successfully to: (1) define and rank-order the effects of selected heavy metals, herbicides, and insecticides on microbes, earthworms, plant seeds, algae, daphnia, and fathead minnow larvae; (2) determine that rank-order of sensitivity differs with major toxicant groups; (3) detect the presence of bioactive organic and heavy metal mixtures in field site samples when concentrations of priority organic pollutants did not exceed EPA criteria levels; and (4) identify the basic chemical component of complex waste mixtures which produce environmental toxicological effects. These types of information should be useful in determining the potential effects of NPS pollutants and in designing measures for their control. (See also W88-01083) (Author's abstract)
W88-01088

MONITORING THE EFFECTS TO THE GROUND WATER SYSTEM ATTRIBUTABLE TO AGRICULTURAL PRACTICES,
South Dakota Dept. of Water and Natural Resources, Pierre.
C. G. Kimball.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 125-128, 1 fig, 1 tab, 3 ref.

Descriptors: *Water pollution effects, *Groundwater pollution, *Agriculture, *Conservation, *South Dakota, Fertilizers, Pesticides, Monitoring, Groundwater quality, Nutrients.

A 10-year study to evaluate the effect of three conservation practices - fertilizer management, pesticide management, and conservation tillage on both surface and groundwater is underway in South Dakota. The area of study is in the lakes region of the glaciated part of the State. Glacial till and outwash geologic environments are included. Excessive nutrients have been identified in both wells and lakes. Field monitoring sites from 8 to 32 ha have been selected with and without conservation practices and with and without farming. Monitoring design has been carefully integrated with the site geology and instrumentation is extensive. Surface and groundwater are monitored by sampling for laboratory analysis and by testing in situ. Nutrient and pesticide concentrations are determined. Soil moistures are measured and soil sample extractions analyzed for nutrients to ascertain soil water chemistry and flux rates and their contribution to groundwater. All data are filed in a data management system that can be manipulated as desired. Instrumentation of all field sites is not yet complete. Initial test results indicate both definite and relatively rapid response effects on groundwater quality, in some cases, from both nutrients and one pesticide. Results have both limited value and dependability due to the small number of data collected to date. (See also W88-01083) (Author's abstract)
W88-01106

MONITORING CHANGES IN AGRICULTURAL RUNOFF QUALITY IN THE LAPLATTE RIVER WATERSHED, VERMONT,
Vermont Univ., Burlington. School of Natural Resources.
For primary bibliographic entry see Field 5G.
W88-01117

NONPOINT SOURCE POLLUTION IN THE RICE CREEK WATERSHED DISTRICT - THE RESULTS OF 10 YEARS OF WATER QUALITY MONITORING,
Hickok (Eugene A.) and Associates, Inc., Wayzata, MN.
For primary bibliographic entry see Field 5G.
W88-01118

PESTICIDE MONITORING IN KANSAS SURFACE WATERS: 1973-1984,
Kansas Dept. of Health and Environment, Topeka. Div. of Environment.
For primary bibliographic entry see Field 5B.
W88-01119

U.S. GEOLOGICAL SURVEY'S WATER DATA PROGRAM NEW APPROACHES IN THE 1980'S,
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 7B.
W88-01204

BUREAU OF RECLAMATION'S AUTOMATED HYDROMETEOROLOGIC DATA COLLECTION ACTIVITIES,
Bureau of Reclamation, Washington, DC.
For primary bibliographic entry see Field 7B.
W88-01205

ORGANIZATION OF INSTRUMENTATION CONTROL AND DEVELOPMENT WITHIN THE U.S. GEOLOGICAL SURVEY WATER RESOURCES DIVISION,
Geological Survey, NSTL Station, MS. Water Resources Div.
C. R. Wagner.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 27-29.

Descriptors: *Network design, *Hydrometeorology, *Measuring instruments, *Geological Survey, Hydrologic data, Data acquisition.

The U.S. Geological Survey, Water Resources Division (WRD) has made a major commitment to upgrading hydrologic instrumentation in the 1980's. The Hydrologic Instrumentation Facility (HIF) was established in 1980, and given nationwide responsibility for research, development, testing, evaluation, procurement, warehousing, distribution, repair, and calibration services for hydrologic instrumentation. The reorganization of these activities into a single facility has resulted in improved hydrologic instrumentation services to the Survey. (See also W88-01203) (Author's abstract)
W88-01207

ADAPTABLE HYDROLOGIC DATA ACQUISITION SYSTEM,
Geological Survey, NSTL Station, MS. Water Resources Div.
For primary bibliographic entry see Field 7B.
W88-01209

REAL-TIME HYDROLOGIC DATA ACQUISITION NETWORK FOR THE ARKANSAS RIVER BASIN, COLORADO,
Environmental Research and Technology, Inc., Concord, MA.
For primary bibliographic entry see Field 7B.
W88-01210

DATA TELEMETRY BY METEOR BURST,
Meteor Communications Consultants, Inc., Kent, WA.
For primary bibliographic entry see Field 7B.
W88-01211

RAINFALL RELATED PROBLEMS IN OPERATING THE GARD FLOOD WARNING SYSTEM,
Institut National Polytechnique de Grenoble (France).
For primary bibliographic entry see Field 2E.
W88-01229

OPERATIONAL REMOTE SENSING UNDER EXTREME CONDITIONS,
National Weather Service, Slidell, LA.
For primary bibliographic entry see Field 7B.
W88-01234

METHODOLOGY FOR DEVELOPING OPTIMAL WATER STORAGE STRATEGIES,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
D. G. Fontane, and J. W. Labadie.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 257-261, 2 fig, 4 tab, 10 ref.

Descriptors: *Water yield, *Model studies, *Hydrometeorology, *Water storage, *Water supply, *Water resources management, *Yampa River, *Colorado, Computer models, Water demand, Reservoirs, Economic aspects.

Intensifying demands for water in many areas of the western United States, combined with limited opportunities for constructing new water storage projects, have underscored the need for basinwide, integrated approaches to water development strategies. A computerized model called SCREEN is presented which enables water planners to select storage sites and capacities that meet various water demand scenarios at minimum cost, while considering other objectives such as water quality control and instream flow needs. The model uses an interactive conversational data input and editing format which facilitates use by planners with little familiarity with the computer. The model provides intermediate information during the solution process which allows the planner to make adjustments to reflect noneconomic objectives. The model results can be further refined using a combined simulation-optimization model called OPTRES. Several proposed projects in the Yampa River basin in northwestern Colorado are analyzed by SCREEN as a means of demonstrating its capability. (See also W88-01203) (Author's abstract)
W88-01242

ECOSYSTEMS THEORY AND THE UNEXPECTED: IMPLICATIONS FOR ENVIRONMENTAL TOXICOLOGY,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5C.
W88-01365

OCCUPATIONAL EXPOSURE MONITORING OF WORKERS AT HAZARDOUS WASTE SITES,
National Inst. for Occupational Safety and Health, Cincinnati, OH. Health Hazard and Technical Assistance Branch.
For primary bibliographic entry see Field 5C.
W88-01392

7B. Data Acquisition

HETEROGENEITIES AND WATER QUALITY - UNDERSTANDING DEGRAY LAKE WATER QUALITY THROUGH SAMPLING,
Ford, Thornton, Norton and Associates Ltd., Little Rock, AR.
For primary bibliographic entry see Field 2H.
W88-01077

MONITORING COLDWATER DISCHARGES FROM DEGRAY RESERVOIR USING THERMAL INFRARED IMAGERY,
Army Engineer District, Vicksburg, MS.
For primary bibliographic entry see Field 2H.
W88-01081

PERSPECTIVES ON NONPOINT SOURCE POLLUTION.
For primary bibliographic entry see Field 5B.
W88-01083

MONITORING AND ASSESSMENT TECHNIQUES,
Vermont Univ., Burlington. School of Natural Resources.
For primary bibliographic entry see Field 7A.
W88-01084

CONTINUOUS SALINITY STATION MONITORING IN THE COLORADO RIVER BASIN BY THE UTAH BUREAU OF WATER POLLUTION CONTROL,
Utah Bureau of Water Pollution Control, Salt Lake City.
R. D. Gunnell.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 356-358, 1 fig, 1 tab, 5 ref.

Descriptors: *Salinity, *Water quality control, *Colorado River, *Water pollution control, *Monitoring, *Utah, Dissolved solids, Water quality management, Conductivity, Data acquisition, Pollution load, Water chemistry.

The objectives of this salinity monitoring program are to characterize the Colorado River Basin waters by determining the total dissolved solids loadings entering and leaving Utah and the relative contributions from major basins. A network of nine continuous recording salinity stations collect temperature and specific conductance data. The continuous recording devices consist of Hydrolab Datasondes (registered trademark of Hydrolab Inc.) which are programmed and standardized in Salt Lake City before they are distributed to their specific field locations. Each salinity station is visited monthly to replace the Datasondes and to collect ambient water quality information. The data from the sondes are read and edited into a computer storage file. The conductivity data, along with chemistry and flow data are then combined to determine loadings. (See also W88-01083) (Author's abstract)
W88-01151

USING IN-STREAM MONITORING STATIONS TO EVALUATE POLLUTION FROM URBAN RUNOFF,
South Dakota School of Mines and Technology, Rapid City. Dept. of Civil Engineering.
L. L. Harms.
IN: Perspectives on Nonpoint Source Pollution, Proceedings of a National Conference, Kansas City, MO. May 19-22, 1985. Environmental Protection Agency, 1985. p 502-505, 3 fig, 7 tab, 4 ref.

Descriptors: *Water pollution sources, *Water quality, *Monitoring, *Urban runoff, *Rapid City, *South Dakota, *Rapid Creek, Nonpoint pollution sources, Water analysis, Drainage basins, Water quality standards.

Sampling of urban runoff was conducted for 3 years on five instream stations and one major watershed within the Rapid City, South Dakota drainage basin area. A theoretical station, 56, was used to indicate the instream conditions in Rapid Creek below the urban area. Rapid Creek, a high-quality mountain stream, enters Rapid City from the west after flowing through primarily an undeveloped, forested area. The creek discharge is controlled by a manmade reservoir located approximately 15 miles from Rapid City. No known point sources of pollution are upstream from Rapid City. The creek changes into a slower moving, prairie stream as it exits onto the plain east of the city. The water quality in Rapid Creek is significantly degraded by urban drainage during both snowmelt and rainfall runoff events. Most of the water quality parameters studied increased in concentration at the downstream locations. The water quality standards, except specific conductance, for the stream in question, were violated during runoff events. (See also W88-01083) (Lantz-PTT)
W88-01183

LINEAR-FLOW INTERPRETATION OF THE H-3 MULTIWELL PUMPING TEST CONDUCTED AT THE WASTE ISOLATION PILOT PLANT (WIPP) SITE,
Sandia National Labs., Albuquerque, NM. Earth Sciences Div.
For primary bibliographic entry see Field 2F.
W88-01189

INTERNATIONAL SYMPOSIUM ON HYDROMETEOROLOGY.
American Water Resources Association, Bethesda, MD.
For primary bibliographic entry see Field 2B.
W88-01203

U.S. GEOLOGICAL SURVEY'S WATER DATA PROGRAM NEW APPROACHES IN THE 1980'S,
Geological Survey, Reston, VA.
T. J. Buchanan, and B. K. Gilbert.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 3-7, 1 fig, 4 ref.

Descriptors: *Hydrometeorology, *Geological Survey, *Data acquisition, *Telemetry, *Network design, Water resources development, Hydrologic data, Data storage and retrieval, Satellite technology, Measuring instruments.

The water resources issues of the 1980's will require hydrologic data at many new locations, more data in real-time, and additional parameters to be measured. A refocus of program and improved technology in data collection is necessary to meet these expanding needs. The U.S. Geological Survey provides much of the hydrologic information collected in the U.S. The Survey is evaluating its water data network and developing plans to meet future needs. Network evaluation will provide the opportunity to shift efforts in many areas to effective data collecting activities of greatest need to the Nation. Satellite data transmission is expected to play a most important role in providing the real-time information in water management and flood hazard protection. Modernization of hydrologic instrumentation will make it possible to collect and analyze data in a highly automated fashion, and provide the opportunity to measure more parameters on a real-time basis with a high degree of accuracy. (See also W88-01203) (Author's abstract)
W88-01204

BUREAU OF RECLAMATION'S AUTOMATED HYDROMETEOROLOGIC DATA COLLECTION ACTIVITIES,
Bureau of Reclamation, Washington, DC.
R. H. Ives.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 9-13, 4 ref.

Descriptors: *Telemetry, *Bureau of Reclamation, *Automation, *Hydrometeorology, *Data acquisition, *Network design, Data storage and retrieval, Data collections, Satellite technology, Measuring instruments.

In a variety of programs, the Bureau of Reclamation employs automated data collection platforms (DCP's) to collect hydrometeorologic data and then transmit these data via the Geostationary Operation Environmental Satellite (GOES) system to ground receiving sites. These real-time hydrometeorological data contribute significantly to improved Bureau program operations in weather modification research, wind and solar energy potential site evaluations, and in water resources project operation. The establishment of a Meteorological Surface Observation Network (MESONET), consisting of 128 solar powered DCP's enables Bureau scientists in weather modification research to more accurately monitor weather developments. The deployment of 22 solar powered DCP's at sites with high wind energy potential will permit Bureau engineers to assess the feasibility of installing wind turbine generators at selected sites throughout the West. In addition to being fitted with an anemometer, two of the wind monitoring DCP's are also measuring solar insolation for solar energy potential site evaluations in the Southwest. The Bureau has also installed 66 DCP's and has plans for an additional 110 DCP's in a hydromet system in the Pacific Northwest to provide real-time hydrometeorologic data for making operational decisions to maximize benefits of multi-purpose reservoir systems. Real-time hydrometeorologic data are inexpensive and the data are readily available to users in the Bureau and in other agencies, the data can be immediately integrated with a variety of predictive models, and results are obtained far sooner than would be possible with manual data collection techniques. In addition, for Bureau water resources projects, real-time data can provide the basis for making prompt adjustments in the operational requirements and enhance the ability of Bureau officials to monitor and respond to either drought or flood situations. (See also W88-01203) (Author's abstract)
W88-01205

ADVANCES IN GAUGING OPEN CHANNELS AND RIVERS USING ULTRASONIC AND ELECTROMAGNETIC METHODS,
Sarasota Automation Ltd., Winchester (England). Environmental Systems Div.
J. D. Newman.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 15-26, 10 ref, append.

Descriptors: *Hydrometeorology, *Flow measurement, *Open-channel flow, *Gaging, *Open channels, *Channel flow, *Data acquisition, *Hydrologic data, Measuring instruments, Electromagnetic waves, Flow measurement, Flow velocity.

Two electronic methods of flow measurement are described, which have been developed to overcome some of the limitations of traditional methods of continuous flow measurement in open channels. The first method relies on accurately timing ultrasonic pulses traversing the river at an angle to the flow. The time varies according to the velocity of the water and the discharge can be inferred. The second method is based on electromagnetic induction. Here electrodes set into the river banks pick up a voltage generated by the water flowing through a vertical magnetic field set up by an electromagnet coil. Both methods basically measure the velocity of the water and include a water level gauge to enable the measurement of the cross-sectional area of the river which is combined with the velocity to indicate discharge. The velocity and level measurements are also available as additional river management parameters. The new methods are suitable for gauging flow in rivers and artificial channels. The choice of technique will usually be decided on a cost premise but generally the electromagnetic technique is more suited to channels up to 25 meters wide and the ultrasonic technique is more suited to wider channels. (See also W88-01203) (Author's abstract)
W88-01206

ORGANIZATION OF INSTRUMENTATION CONTROL AND DEVELOPMENT WITHIN THE U.S. GEOLOGICAL SURVEY WATER RESOURCES DIVISION,
Geological Survey, NSTL Station, MS. Water Resources Div.
For primary bibliographic entry see Field 7A.
W88-01207

CRITICAL ANALYSIS OF FIVE YEARS OF SNOTEL PERFORMANCE IN THE ROCKY MOUNTAINS,
Soil Conservation Service, Denver, CO.
G. L. Schaefer, and B. A. Shafer.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 31-37, 7 fig, 6 ref.

Descriptors: *Rain gages, *Evaluation, *SNOTEL, *Data acquisition, *Snow, *Hydrometeorology, *Telemetry, Measuring instruments, Gages.

In 1978, the USDA Soil Conservation Service began receiving hydrometeorological information through the first operational meteorburst communication system called SNOTEL (snow telemetry). A comparative analysis of snow pillow sensors and precipitation gage catch in the variable snow-pack environments in the Colorado and New Mexico Rockies for a five-year period (1978-82) is provided. Telemetered data are compared to 'ground truth' measurements and an explanation given for some anomalous events. During this five-year period, there were several extreme years of record providing a wide range of hydrometeorological conditions under which to examine system performance. Telemetered data are found to be of sufficient accuracy for water supply forecasting applications. A discussion of second generation units incorporating a microprocessor programmed to perform numerous functions, including computing minimum, maximum, and average air temperature, as well as event recording is presented. A subtelemetry network has been developed to add more remote sites to the SNOTEL system without adding more costly meteorburst transceivers. (See also W88-01203) (Author's abstract)
W88-01208

ADAPTABLE HYDROLOGIC DATA ACQUISITION SYSTEM,
Geological Survey, NSTL Station, MS. Water Resources Div.
R. H. Billings, and V. J. Latkovich.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 39-41, 1 fig, 1 ref.

Descriptors: *Telemetry, *Hydrologic data, *Data acquisition, *Network design, *Hydrometeorology, Automation, Measuring instruments, Microprocessors, Data transmission.

Some programs of the U.S. Geological Survey require collecting hydrologic and hydrometeorologic data in a continuous and unattended manner. A system of automatic instruments is used to collect these data throughout the United States at an estimated 15,000 sites that were established in piecemeal fashion over more than two decades. The system is no longer able to keep pace with the demand for increased performance. An Adaptable Hydrologic Data Acquisition System (AHDAS), custom designed to the particular requirements of the Survey, is under development. AHDAS will be a system of complementary instruments and modules which may be arranged to fit any practical data collection application. It will incorporate intelligent, programmable microprocessor features with solid state data memory and be capable of operation with a full spectrum of existing and even future sensors, communications systems, and peripherals. AHDAS will be a flexible system that may be altered in size and shape to provide total support for an estimated 20 years. (See also W88-01203) (Author's abstract)
W88-01209

REAL-TIME HYDROLOGIC DATA ACQUISITION NETWORK FOR THE ARKANSAS RIVER BASIN, COLORADO,
Environmental Research and Technology, Inc., Concord, MA.
R. Tatnall, and P. Kirshen.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 43-49, 7 fig.

Descriptors: *Telemetry, *Hydrometeorology, *Hydrologic data, *Data acquisition, *Network design, *Arkansas River, *Colorado, Salinity, Water temperature, Satellite technology, Data transmission.

A commercial real-time hydrologic data collection network of 81 sites has been set up in the Arkansas River Basin in Colorado by Environmental Research and Technology, Inc. (ERT), a subsidiary of COMSAT. Stage is monitored at all sites; salinity and water temperature are monitored at several sites. The data from the sensors are transmitted via the GOES satellite to ERT's downlink in Concord, Massachusetts, and then relayed to users in the field by dedicated telephone lines. The stage sensors are either maintained by a cooperating agency or ERT. At all sites, however, ERT owns, operates, and maintains the transmitting and associated equipment. ERT also provides quality control for the data collection. Users have access to the data and associated software products as needed for a monthly fee. Examples of standard software products include archived records, emergency transmissions, hydrographs, and excedences of threshold values. Site specific products such as forecast and operational models are also available. The advantages of the commercial system to users are that large capital expenditures are avoided, only necessary data are purchased, manpower requirements are kept low, many of the research and development efforts in data collection and system operation are undertaken at no cost by ERT, and finally, the economic nature of the system encourages cooperation between various kinds of data users. (See also W88-01203) (Author's abstract)
W88-01210

DATA TELEMETRY BY METEOR BURST,
Meteor Communications Consultants, Inc., Kent, WA.
D. Sytsma, and R. E. Leader.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 51-55, 6 fig.

Descriptors: *Hydrometeorology, *Data transmission, *Telemetry, *Meteor bursts, *Data acquisition, *Network design, Meteorology, Forecasting, Precipitation.

An introduction to meteor burst technology and its general application for the telemetry of hydrometeorology data is provided. Two specific applications featured are: (1) Coastal measurement system; and (2) Event reporting for flood forecasting. In the fall of 1981, a Coastal Management System, using meteor burst as the principal telemetry link, was installed off Kodiak Island, Alaska. The purpose of the system is to gather wave data from two buoys, wind data from a nearby island, telemetering a synopsis of this data directly to the engineering offices of the Corps of Engineers in Anchorage. The data is being used in the final design of a breakwater to be constructed in Chiniak Bay. Event reporting for flood forecasting at Mt. St. Helens is described as the second application. Seven meteor burst sites were installed on and around Mt. St. Helens, Washington, to provide event reporting for rapid changes in precipitation and snowfall. Upon the occurrence of an event, the appropriate SCS offices in Portland, Oregon and Spokane, Washington, are notified immediately. (See also W88-01203) (Author's abstract)
W88-01211

SUITABILITY OF REMOTE SENSING CAPABILITIES FOR USE IN HYDROLOGIC MODELS,
Hydex Corp., Fairfax, VA.
E. L. Peck, T. N. Keefer, and E. R. Johnson.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 59-63, 1 fig, 3 tab, 2 ref. NASA Contract No. NAS5-26446.

Descriptors: *Model studies, *Hydrometeorology, *Remote sensing, *Hydrologic models, Data acquisition, Water resources development, Model studies, API, CREAMS, NWSRFS, STORM, STANFORD, SSARR, NWSRFS, Computer models.

The results of a study on the suitability of remote sensing capabilities for use in hydrologic models is reported. Seven hydrologic models (API, CREAMS, NWSRFS, STORM, STANFORD, SSARR, and NWSRFS Snowmelt) are reviewed. Information on the primary and secondary roles of parameter and state variables with respect to their function in the models is used to determine the usefulness of six remote sensing capabilities with the seven hydrologic models. The results indicate remote sensing information has only limited value for use with the hydrologic models in their present form. The usefulness of the remote sensing information would be greatly enhanced with minor modification to the models. General characteristics of a hydrologic model needed to make maximum use of remotely sensed data in specific models. (See also W88-01203) (Author's abstract)
W88-01212

RUNOFF CURVE NUMBER ESTIMATION USING REMOTE SENSING TECHNIQUES,
Morrison-Knudsen Co., Inc., Boise, ID.
K. Johnson, S. Dhamotharan, and S. Allred.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 65-67, 1 fig, 1 tab, 10 ref.

Descriptors: *Runoff rate, *Hydrometeorology, *Runoff forecasting, *Remote sensing, *Data acquisition, Mathematical studies, Ground cover.

Soil Conservation Service Runoff curve numbers are being extensively used by hydrologists to predict runoff values, especially in ungaged watersheds. The reliability of this method depends heavily on the determination of the individual runoff curve numbers. This becomes more critical in extremely nonuniform watersheds such as those in western river basins where energy development projects are being planned. Accurate information on curve number parameters on the subbasin level are a prerequisite to reliable runoff values. Detailed manual surveys to obtain necessary information is always expensive. It is demonstrated herein that remote sensing techniques can be used for runoff curve number estimation to the required level of precision with a significant savings of time and money. Ground cover distribution, within the basin being studied, is determined by spectral classification to a map base to produce a ground cover map. Using digital image processing techniques, digital maps of soil hydrologic groups, and individual drainage subbasins are prepared to produce a basinwide geographic data base. An estimated runoff curve number map is produced by combining field observations of cover density, the ground cover map, and the soils map. By digitally overlaying the curve number map and drainage basin maps, an average curve number estimate for each drainage basin is determined. This methodology can provide a cost-effective means of obtaining comprehensive curve number parameters with a minimum of field observations and with a statistically significant result. (See also W88-01203) (Author's abstract)
W88-01213

SATELLITE TECHNIQUE FOR ESTIMATING RAINFALL FROM FLASH FLOOD PRODUCING THUNDERSTORMS,
National Earth Satellite Service, Washington, DC.
For primary bibliographic entry see Field 2B.
W88-01224

FORECASTING CONVECTIVE PRECIPITATION BY TRACKING CLOUD TOPS IN GOES IMAGERY,
National Earth Satellite Service, Washington, DC.
For primary bibliographic entry see Field 2B.
W88-01225

ESTIMATING RAINFALL USING SATELLITE IMAGERY FOR WARM-TOP THUNDERSTORMS EMBEDDED IN A SYNOPTIC-SCALE CYCLONIC CIRCULATION,
National Earth Satellite Service, Washington, DC.
For primary bibliographic entry see Field 2B.
W88-01226

OBJECTIVE ANALYSIS OF RAINFALL DATA FROM DIGITAL RADAR AND RAIN GAGE MEASUREMENTS,
National Weather Service, Silver Spring, MD. Office of Hydrology.
W. F. Krajewski, and K. C. Crawford.

IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 147-152, 4 fig, 15 ref.

Descriptors: *Hydrometeorology, *Metorological data, *Rainfall, *Data acquisition, *Radar, *Rain gages, Rainfall intensity, Hydrologic models, Mathematical analysis, Measuring instruments, Data interpretation.

Two devices are used to perform measurements of rainfall: digital radar and rain gages. Each of them gives different types of information. Digital radar data represent a spatial pattern of a storm but the point estimates may be biased through, for example, the reflectivity-rainfall transfer relationship. A standard rain gage optimally sited generally gives a very good estimate of rainfall at a point, but the measurement often is not representative over a larger area. A multivariate regression model has been developed to merge those two kinds of data into an optimal (in a statistical sense) estimate of rainfall. Such optimal estimates can then be used as input to hydrological models. Plans for operational implementation of the regression model are presented as well as results of example data analysis from the National Weather Service Radar at Oklahoma City. Computer requirements are discussed and some aspects of potential future improvements are mentioned. These include the possibility of accounting for the autocorrelation of errors and the inclusion of satellite data. (See also W88-01203) (Author's abstract)
W88-01227

STRUCTURE OF HOMOGENEOUS ANISTROPIC CORRELATION FUNCTIONS FOR REAL-TIME RADAR RAINFALL ESTIMATION,
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
N. R. Dalezios, and N. Kouwen.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 153-157, 3 fig, 1 tab, 9 ref.

Descriptors: *Hydrometeorology, *Remote sensing, *Rainfall variability, *Rainfall intensity, *Radar, *Anisotropy, *Statistical analysis, Statistical models, Multivariate analysis, Meteorology, Model studies.

Rainfall variability is one of the major problems in hydrology. Conventional rain gage data combined with digitized radar reflectivities can provide powerful techniques for monitoring the quantitative rainfall distribution in time and space. An objective analysis technique was performed, which accounts for the analysis of multivariate data sets. In particular, bivariate analyses are discussed that use rain gage/radar data sets. This involves the estimation of correlation and cross-correlation functions which model the spatial and temporal structure of a storm. In this work, Gaussian two-dimensional homogeneous anisotropic correlation and cross-correlation models have been derived. Since the application is on real-time surface rainfall estimation, the model focuses on the spatial structure of the phenomenon. Specifically, the dependence of the decorrelation distance upon certain meteorological parameters, which are embedded in the prevailing weather system, is shown to be critical and offers an improvement on the existing correlation models. A Canadian 5 cm weather radar was employed and the analyses performed on typical spring and summer storms in Southern Ontario. (See also W88-01203) (Author's abstract)
W88-01228

UTILIZATION OF HYDROMETEOROLOGICAL MONITORING SYSTEMS TO ENHANCE RESERVOIR OPERATIONS DURING FLOOD EMERGENCIES,
Salt River Project, Phoenix, AZ. Water Resources Operations.
For primary bibliographic entry see Field 2E.
W88-01232

OPERATIONAL REMOTE SENSING UNDER EXTREME CONDITIONS,
National Weather Service, Slidell, LA.
J. D. Belville, and B. J. Crouch.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 201-204, 4 fig, 2 tab, 2 ref.

Descriptors: *Hydrometeorology, *Flood warning, *Warning systems, *Telemetry, *Remote sensing, *Network design, *Rio Grande, Satellite technology, Floods.

The Rio Grande, satellite-interrogated Automatic Hydrologic Observing System flood warning network, operated jointly by the International Boundary and Water Commission (IB and WO) and the National Weather Service, is described. Since its establishment in 1976, this system has provided timely and accurate hydrologic information on flow into a lake under the joint control of the United States and Mexico. In November, 1978, the satellite-interrogated system successfully detected a major Rio Grande Flood under the most extreme conditions which could be expected. Water rose to a level never before observed on this particular river, completely submerging several components of the system within the gage house. However, the system continued to work flawlessly providing the critically needed information. Also included in the paper is information describing the network design and rationale behind it. A detailed description of the system and its components is also provided. (See also W88-01203) (Author's abstract)
W88-01234

FREQUENCY ESTIMATES OF WATER AVAILABLE FOR RUNOFF DUE TO PRECIPITATION AND/OR SNOWMELT,
National Weather Service, Silver Spring, MD. Office of Hydrology.
For primary bibliographic entry see Field 2E.
W88-01287

WATER QUALITY MONITORING USING SATELLITE DATA TRANSMISSION,
Water and Power Resources Service, Denver, CO. Engineering and Research Center.
For primary bibliographic entry see Field 5G.
W88-01329

FIELD TEST FOR EFFECTIVE POROSITY AND DISPERSIVITY IN FRACTURED DOLOMITE, THE WIPP, SOUTHEASTERN NEW MEXICO,
Sandia National Labs., Albuquerque, NM.
For primary bibliographic entry see Field 5B.
W88-01352

GROUNDWATER QUALITY PROTECTION AIDED BY REMOTE SENSING,
O. Radai.
United Nations, Economic Commission for Europe. WATER/SEM.14/R.9, March 3, 1987. 7 p, 8 ref.

Descriptors: *Remote sensing, *Satellite technology, *Aerial photography, *Infrared imagery, *Hungary, *Groundwater pollution, *Water pollution control, Water quality management, Water quality control, Surface runoff, Infiltration, Karst hydrology, Water pollution sources, Groundwater management.

Remote sensing methods, such as aerial photography and satellite image interpretation plus infrared scanning are used in Hungary for the protection of subsurface water both in the sense of quality and quantity. Aerospace images are partly archive ones, representing a former, less disturbed status of the environment, and new ones depicting the recent situation. Special purpose infrared scanning (airborne) yielded thermograms of a lake fed by a hot spring, and helped in detecting the existence of springs suspected on the bottom of Lake Balaton. Infiltration promoted by thin soil-cover, or by the total absence of soil and impervious cover plus surface runoff-retarding depressions and karstic phenomenon could be identified. Very detailed data were obtained regarding tectonics, potential pollution sources and points, and lines or surfaces through which pollutants may reach subsurface water bodies. (Author's abstract)
W88-01402

WATER CONTROL AT THE BAKONY BAUXITE MINES COMPANY,
Bakonyi Bauxitbany Vallalat, Topolca (Hungary).
For primary bibliographic entry see Field 4B.
W88-01422

TECHNIQUE OF FLOWMETERING INVESTIGATIONS AT INTERVALS IN GROUT HOLES,
STG Specialized Association, Antratsit (USSR).
O. J. Lushnikova.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 395-401, 1 fig, 1 tab.

Descriptors: *Data acquisition, *Flow measurement, *Flow discharge, *Groundwater movement, *Measuring instruments, *Geologic fractures, Rock properties, Aquifers, Boreholes, Permeability, Grout, Fluid flow.

A technique which enables flowmetering at specified intervals without borehole casing to detect fluid loss within the strata thickness and to determine filtration parameters and the extent of rock fissuring was developed. The drill stem models previously available allowed only the average evaluation of aquifer filtration properties and could not define either aquifer nonhomogeneity or spacing, size and water yield of each fissure. The instrument designed for flowmetering overcame the inadequacies of the available instruments by anchoring a packer in the roof of the test zone and having a diameter close to that of a borehole to provide an accurate flowmetering record for the liquid discharge. With the new STG-3P flowmeter it was possible to: (1) test each aquifer at intervals both during pumping-out and pumping-in at stationary and nonstationary filtration regimes, (2) eliminate large diameter drilling and casing, (3) test all aquifers regardless of permeability, strata pressure and bedding depth, and (5) determine all filtration parameters and strata fissuring characteristics at intervals. (See also W88-01408) (Wood-PTT)
W88-01441

7C. Evaluation, Processing and Publication

CONTINUOUS SALINITY STATION MONITORING IN THE COLORADO RIVER BASIN BY THE UTAH BUREAU OF WATER POLLUTION CONTROL,
Utah Bureau of Water Pollution Control, Salt Lake City.
For primary bibliographic entry see Field 7B.
W88-01151

DATA MANAGEMENT SYSTEM TO EVALUATE WATER QUALITY IMPACTS OF NONPOINT SOURCE POLLUTION CONTROL,
North Carolina State Univ., Raleigh.
For primary bibliographic entry see Field 5G.
W88-01167

DEVELOPMENT OF A NONPOINT SOURCE DATA CENTER,
Synectics Group, Inc., Washington, DC.
For primary bibliographic entry see Field 5G.
W88-01168

WATER QUALITY DATA AND URBAN NONPOINT SOURCE POLLUTION: THE NATIONWIDE URBAN RUNOFF PROGRAM,
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 5G.
W88-01169

RFF NATIONAL DATA BASE FOR NONPOINT SOURCE POLICY ASSESSMENTS,
Resources for the Future, Inc., Washington, DC.
For primary bibliographic entry see Field 5G.
W88-01170

EVAPORATION TIME SERIES ANALYSIS FOR MILFORD LAKE IN KANSAS,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 2D.
W88-01216

FORECASTING SNOWMELT RUNOFF,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2C.
W88-01236

FORECASTING DAILY PRECIPITATION OCCURRENCES WITH MARKOV CHAIN OF SEASONAL ORDER,
National Technical Univ., Athens (Greece). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W88-01237

POSSIBLE USES OF LONG-RANGE WEATHER OUTLOOKS IN WATER RESOURCES,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 6B.
W88-01239

EXPERIMENTAL WATER SUPPLY FORECASTS BASED ON SEASONAL PRECIPITATION FORECASTS,
California State Dept. of Water Resources, Sacramento.
For primary bibliographic entry see Field 3B.
W88-01240

TRENDS AND EXTREMES OF LAKE ERIE WATER SUPPLIES,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 2H.
W88-01244

APPLICATION OF IFG'S INSTREAM WATER TEMPERATURE MODEL IN THE UPPER COLORADO RIVER,
Soil Conservation Service, Fort Collins, CO.
For primary bibliographic entry see Field 2E.
W88-01248

DROUGHT HISTORY IN THE WESTERN GREAT PLAINS FROM TREE RINGS,
Arizona Univ., Tucson. Lab. of Tree-Ring Research.
For primary bibliographic entry see Field 2A.
W88-01254

PROBABILITY OF DROUGHT COVERAGE WITH VARIOUS RETURN PERIODS FOR JAPAN,
Tsukuba Univ. (Japan). Inst. of Geoscience.
For primary bibliographic entry see Field 2A.
W88-01255

MEASURING DROUGHT SEVERITY AND ASSESSING IMPACT,
Nebraska Univ.-Lincoln. Center for Agricultural Meteorology and Climatology.
For primary bibliographic entry see Field 2A.
W88-01256

DEVELOPMENT OF A SURFACE WATER SUPPLY INDEX - A DROUGHT SEVERITY INDICATOR FOR COLORADO,
Colorado Div. of Water Resources, Denver.
For primary bibliographic entry see Field 2E.
W88-01257

USE OF HYDROMETEOROLOGICAL DATA IN DROUGHT MANAGEMENT: POTOMAC RIVER BASIN CASE STUDY,
Interstate Commisson the Potomac River Basin, Rockville, MD. Cooperative Water Supply Operations on the Potomac River.
For primary bibliographic entry see Field 2E.
W88-01259

SPATIAL CHARACTERISTICS OF SEVERE DROUGHT IN THE SACRAMENTO RIVER BASIN,
California Univ., Davis. Dept. of Geography.
For primary bibliographic entry see Field 2E.
W88-01260

EVALUATION OF OPERATIONAL CLOUD SEEDING PROJECTS,
Illinois State Water Survey Div., Champaign. Meteorology Section.
For primary bibliographic entry see Field 3B.
W88-01264

CLIMATOLOGICAL BACKGROUND STUDIES FOR OPERATIONAL WEATHER MODIFICATION,
Oklahoma Climatological Survey, Norman.
For primary bibliographic entry see Field 3B.
W88-01266

SITE SPECIFIC PROBABLE MAXIMUM PRECIPITATION ESTIMATES, UPPER SOUTH PLATTE RIVER BASIN, COLORADO,
For primary bibliographic entry see Field 2E.
W88-01284

FREQUENCY ESTIMATES OF WATER AVAILABLE FOR RUNOFF DUE TO PRECIPITATION AND/OR SNOWMELT,
National Weather Service, Silver Spring, MD. Office of Hydrology.
For primary bibliographic entry see Field 2E.
W88-01287

FLOOD FREQUENCY ANALYSIS WITH DETECTION AND MODIFICATION OF OUTLIERS,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 2E.
W88-01288

2-MINUTE RAINFALL EXTREMES,
Agricultural Research Service, Beltsville, MD. Hydrology Lab.
For primary bibliographic entry see Field 2B.
W88-01295

GROUNDWATER HYDRAULICS.
For primary bibliographic entry see Field 2F.
W88-01344

PUMPING TEST ANALYSIS IN FRACTURED AQUIFER FORMATIONS: STATE OF THE ART AND SOME PERSPECTIVES,
Research Council of Alberta, Edmonton.
For primary bibliographic entry see Field 2F.
W88-01351

DIRECT CALCULATION OF AQUIFER PARAMETERS IN SLUG TEST ANALYSIS,
Princeton Univ., NJ. Water Resources Program.
For primary bibliographic entry see Field 2F.
W88-01353

PRESSURE TRANSIENT ANALYSIS FOR HOT WATER GEOTHERMAL WELLS,
Systems, Science and Software, La Jolla, CA.
For primary bibliographic entry see Field 2F.
W88-01354

ANALYTICAL GROUNDWATER MODELING WITH PROGRAMMABLE CALCULATORS AND HAND-HELD COMPUTERS,
Geraghty and Miller, Inc., Savoy, IL.
W. C. Walton.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 298-312, 4 tab, 6 ref.

Descriptors: *Model studies, *Data interpretation, *Mathematical models, *Pumping tests, *Groundwater, *Groundwater movement, Simulation, Computers, Computer programs, Mathematical equations, Wells.

Analytical models simulating the flow of groundwater to and from wells and streams, mass and heat transport in aquifer systems, and land subsidence due to artesian pressure decline have previously been developed for many aquifer systems, and well or stream conditions. Application of these models to various aquifer conditions is advancing through equivalent section, incremental, and successive approximation techniques. Programmable calculators and pocket computers are available for rapid, accurate and inexpensive solution of analytical model equations. Although not as versatile as numerical digital computer models, analytical models continue to play an important role in groundwater resource evaluation. The types of groundwater conditions for which analytical models are available were reviewed. An example of a program description, user instructions, and code for a programmable calculator for the modeling of an infinite nonleaky artesian aquifer with a single well is presented. (See also W88-01344) (Wood-PTT)
W88-01356

NUMERICAL TREATMENT OF LEAKY AQUIFERS IN THE SHORT-TIME RANGE,
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Investigacion en Matematicas Aplicadas y en Sistemas.
B. Chen, and I. Herrera.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 313-327, 1 fig, 4 tab, 11 ref.

Descriptors: *Groundwater movement, *Model studies, *Numerical models, *Mathematical models, *Data interpretation, *Leaky aquifers, Aquitards, Mathematical equations, Mathematical studies, Pumping, Aquifers.

Mathematically, leaky aquifers are characterized by the assumption of vertical flow in the aquitards. Previous methods of numerical modeling of systems of leaky aquifers and their shortcomings are reviewed. Numerical modeling in the short-time range is difficult because of the actual physical situation. When pumping first starts in the main aquifer, the effects are first manifested there and then slowly propagate into the aquitard. The short-time range corresponds to that period of time during which the part of the aquitard that is responding to pumping is much smaller than the total thickness of the aquitard. If a uniform mesh is used on the whole aquitard, it would have to be very refined thus introducing too many nodes. When the integrodifferential equation approach is used, these facts are reflected in the number of terms that are required in the series expansion of the memory functions. A procedure that to a large extent avoids these difficulties is presented. The method is based on the observation that in the short-time range, the response of the aquitard is approximately the same as if the thickness of the aquitard is infinity. In the integrodifferential approach, this gives rise to a one-parameter family of possible representations for the memory function. A procedure is presented that adjusts that parameter in order to decrease the number of terms in the series expansion to a minimum. A criterion that permits advance definition of the number of terms required to obtain a given level of accuracy is supplied. Examples of application to actual field situations are presented. (See also W88-01344) (Wood-PTT)

W88-01357

GROUNDWATER MODELING OF DETAILED SYSTEMS,
Hydro-data, Inc., Tempe, AZ.
H. E. Skibitzke, and J. M. Turner.
IN: Groundwater Hydraulics. Water Resources Monograph Series 9. American Geophysical Union, Washington, DC. 1984. p 328-343, 8 fig.

Descriptors: *Model studies, *Mathematical models, *Data interpretation, *Groundwater movement, Analog models, Digital models, Aquifers, Computers, Economic aspects.

A comparison of the analog and digital modeling techniques as used to analyze groundwater conditions showed that both have highly desirable characteristics as well as drawbacks especially for industries such as mining. Where complex conditions exist, large, finely detailed models are required to describe the geologic parameters of the affected aquifers, and long computer runs are required to simulate pumping over long time periods. The presence of faulted or fractured rock areas causes more complications in the model. In multilayered aquifers where layers are interconnected due to faulting and fracturing, the matrix bandwidths become very large. Using digital techniques, instability is very likely to occur at some point in the analysis, but a return to the older analog techniques is unthinkable. By using the best of both systems, the more efficient and precise input and output functions of the digital techniques and stable computations of the analog methods, it is possible to produce detailed solutions to groundwater problems at lower costs. The integration of analog and digital techniques was accomplished by replacing analog hardware with digital software. An example of the hybrid approach involving a complex groundwater evaluation for a mining operation is presented. Diagrams showing the analog-to-digital and digital-to-analog processes and a converter to accomplish these processes are included. (See also W88-01344) (Wood-PTT)
W88-01358

FORMULATION OF MODELS BASED ON THE AVERAGE CHARACTERISTICS OF A HETEROGENEOUS AQUIFER,
Florida Univ., Gainesville.
For primary bibliographic entry see Field 5B.
W88-01359

UNIFIED APPROACH TO REGIONAL GROUNDWATER MANAGEMENT,
Humboldt State Univ., Arcata, CA.
For primary bibliographic entry see Field 4B.
W88-01361

DEVELOPMENT OF AN OPEN PIT COAL MINE DEWATERING PLAN IN CESAR DEPARTMENT, COLOMBIA, S.A.,
Independent Consultants, Denver, CO.
For primary bibliographic entry see Field 4B.
W88-01416

ANALYTICAL AND GRAPHICAL TECHNIQUE TO DETERMINE THE SPACING OF DRAINAGE WICKS FOR PRESSUE RELIEF IN AN OPEN PIT COAL MINE,
Atomics International Div., Richland, WA. Energy Systems Group.
For primary bibliographic entry see Field 4B.
W88-01417

FINITE ELEMENT APPROXIMATION OF NONLINEAR FLOW IN POROUS MEDIA,
Universidad Politechnica de Madrid (Spain). Dept. de Calculo Numerico e Informatica.
For primary bibliographic entry see Field 2F.
W88-01448

8. ENGINEERING WORKS

8A. Structures

DESIGN, CONSTRUCTION, AND OPERATION OF DEGRAY LAKE,
Army Engineer District, Vicksburg, MS.
W. D. Hill, and L. E. Banks.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 102-127, 12 ref.

Descriptors: *Dams, *DeGray Lake, *Reservoirs, *Arkansas, Hydraulic structures, Dam construction, Dam design, Operation.

The DeGray multiple-purpose flood control and power reservoir was included in Senate Document Numbered 117, 81st Congress, first session, as a feature of the comprehensive plan of improvement for the Ouachita River and Tributaries, Arkansas and Louisiana. The projects included in this document were authorized by the River and Harbor Act of 1950. The inclusion of municipal and industrial water supply as one of the project purposes was authorized by the 'Water Supply Act of 1958,' approved 3 July 1958, as amended by the 'Federal Water Pollution Control Act Amendment of 1961,' approved 20 July 1961. The approving documents resulted in the 'DeGray Project' consisting of a multipurpose reservoir with project purposes of flood control, hydroelectric power generation, recreation, water supply and water quality control. DeGray project design, construction, and operation are described at length in this paper, discussing topics which range from outlet structure and turbine capability, to flood control operation and recreation. (See also W88-01056) (Lantz-PTT)
W88-01060

NORTH DIVERSION STRUCTURE ALBUQUERQUE, NEW MEXICO,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
C. H. Tate.
Available from the National Technical Information Service, Springfield, VA. 22161. Hydraulic Model Investigation. Technical Report HL-87-8, May 1987. Final Report. 51 p, 18 photos, 11 plates, 2 append.

Descriptors: *Canals, *Flood control, *Hydraulic structures, *Hydraulic models, *North Diversion, *Albuquerque, *New Mexico, *Rio Grande, Channel flow, Flow characteristics, Scour, Riprap.

The North Diversion Structure diverts storm runoff around Albuquerque, New Mexico, to the Rio Grande. Observed flow conditions at the Alameda Outlet Structure, where the flow is transitioned from supercritical to subcritical, have caused concern about the capacity of the as-built channel. A 1:40-scale model was used to determine the flow conditions approaching and through the Alameda Outlet Structure. Included in the model were approximately 1,500 ft of trapezoidal channel, the vehicle access ramp cut in the side of the trapezoidal channel, the trapezoidal to rectangular transition, the super-elevated curve, Camino Arroyo Inlet, the flaring Alameda Outlet Structure with the railroad bridge and high velocity pier, and the outlet channel with the graded riprap protection. The design capacity of the North Diversion Structure is 44,000 cfs. Flows in the model overtopped the channel walls for discharges above 30,000 cfs due to standing waves that formed at the vehicle access ramp. Removing the vehicle access ramp kept the flow within the channel except on the downstream side of Camino Arroyo Inlet where the flow ran up the wall. A deflector was designed to contain the runup flow within the channel. An envelope curve of discharge and tailwater elevation at the railroad bridge that defined the conditions dangerous to the bridge was developed. Tailwater rating curves were developed and compared with the danger zones. These curves passed through the danger zone with the as-built structure. Diagonal sills 1-ft high were designed that minimized the danger to the railroad bridge. It was determined that improving the exit channel and lowering the tailwater elevation would provide additional safety. Scour conditions in the outlet channel were identified. The riprap protection for the channel invert was stable with discharges up to 28,000 cfs. Flow in Camino Arroyo Inlet overtopped the converging walls in the drop inlet for flows above 2,700 cfs. (Author's abstract)
W88-01186

STRENGTH DESIGN OF REINFORCED CONCRETE HYDRAULIC STRUCTURES. REPORT 5: EXPERIMENTAL STUDY ON THE ULTIMATE BEHAVIOR OF MODEL REINFORCED CONCRETE CIRCULAR CONDUITS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.
R. S. Wright, and V. P. Chiarito.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report SL-80-4, April 1987. Report 5 of a Series. 192 p, 4 fig, 12 tab, 10 ref, 8 append.

Descriptors: *Hydraulic structures, *Reinforced concrete, *Design criteria, *Concrete technology, Hydraulic models, Concrete testing, Materials testing.

A test program was initiated to investigate the two-dimensional failure response of reinforced concrete (R/C) circular conduits under a known 16-point loading. This was achieved by testing 18 R/C models to failure. The test specimens were instrumented to obtain concrete and steel strains and intrados deflections at the crown and springing line. Steel percentage ratios, loading distribution, and curvatures were varied for each test. All models failed primarily in flexure; ductile and brittle modes were observed. In a later test program, models which were exposed to a 2-point and 4-point loadings and the three-edge-bearing method failed in diagonal or radial tension. (Author's abstract)
W88-01188

SHELDRAKE RIVER TUNNEL, MAMARONECK, NEW YORK,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
C. H. Tate.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report HL-86-7, December 1986. Final Report. 110 p, 5 fig, 1 tab, 21 photos, 80 plates.

Descriptors: *Sheldrake River Tunnel, *Mamaroneck, *New York, Hydraulic models, Hydraulic structures, Tunnels, Flow profiles, Tides, Riprap, Flow velocity.

A permanent diversion of the Sheldrake River, in southeast New York, from upstream of the confluence with the Mamaroneck River through a concrete-lined tunnel into the West Basin of the Mamaroneck Harbor is proposed. Included in the proposed plan are improvement of the existing channel, construction of an uncontrolled ogee drop structure and converging approach to a tunnel inlet portal, construction of 2,550 ft of concrete-lined tunnel, including a 16.25 sq ft section and a 17.5 ft horseshoe section with an intermediate transition, and construction of a standard stilling basin energy dissipator at the juncture with the West Basin. A 1:25-scale model was used to determine the flow conditions in the proposed project for Manning's n values of 0.013 and 0.010 up to the Standard Project Flood (SPF), which peaked at 4,039 cfs. Tide effects were investigated for tides fo -2.7 ft, 6.7 ft, 10.0 ft, and 16.8 ft, National Geodetic Vertical Datum. Flow conditions were improved in the model by modifying the tunnel alignment, the shape of the tunnel, and transitions near the middle of the tunnel. The stilling basin was modified to improve flow conditions for the varying tide effects. Riprap protection downstream of the stilling basin was verified as being adequate for the SPF. Stage-discharge relations were determined as were flow velocities and water-surface profiles in the tunnel approach. Hydraulic grade lines were determined for the tunnel for several flows. Flow velocities at the stilling basin end sill

are presented as are velocities in the West Basin of the Mamaroneck Harbor. (Author's abstract)
W88-01192

FLOATING DEBRIS CONTROL; A LITERATURE REVIEW,
Cold Regions Research and Engineering Lab., Hanover, NH.
For primary bibliographic entry see Field 4A.
W88-01193

SYNTHETIC UNIT-HYDROGRAPH PARAMETERS: DAM SAFETY PROGRAM,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 8B.
W88-01293

DESIGN OF A PRECAST CONCRETE STAY-IN-PLACE FORMING SYSTEM FOR LOCK WALL REHABILITATION,
ABAM Engineers, Inc., Federal Way, WA.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report REMR-CS-7, July 1987. Final Report. 91 p, 7 fig, 3 tab, 17 ref, 3 append. Contract No. DACW39-86-C-0014.

Descriptors: *Precast concrete, *Design standards, *Lock walls, *Concrete construction, *Navigation canals, *Locks, Concrete technology, Concretes, Structural engineering, Hydraulic structures, Concrete testing.

The general approach to lock wall rehabilitation has been to remove 1 to 3 ft of concrete from the face of the lock wall and replace it with new air-entrained concrete. It has been postulated that by using precast concrete as a stay-in-place form for the replacement concrete, cracking problems can be eliminated. This report describes the design of such a forming system. A range of design alternatives was evaluated through a process of value engineering and horizontal precast panels constructed of conventional precast quality concrete were selected for detailed quantitative investigation. The panels are tied to the lock monolith along the top and bottom edges using form ties designed to support the loads of the infill concrete placement. The precast concrete stay-in-place forming system is a viable method for lock wall rehabilitation. In addition to providing a concrete surface of superior durability with minimal cracking, the estimated construction cost is about 15% less than conventional forming and concrete placement. Another advantage of the system is the potential reduction in the length of time that a lock must be closed to traffic during rehabilitation. With proper detailing, sequencing, and scheduling of work activities, the rehabilitation work may be accomplished with minimized impact on normal lock traffic. (Author's abstract)
W88-01407

CONSOLIDATION OF TECTONIC RUPTURES USING CLAY-CEMENT GROUTS DURING TUNNEL DRIVING,
STG Specialized Association, Antratsit (USSR).
For primary bibliographic entry see Field 8G.
W88-01442

STUDY OF PRETREATMENT GROUTING TECHNOLOGY AT WORKING FACE IN AN AUXILIARY SHAFT OF HUANGHUAI COAL MINE,
Beijing Research Inst. of Mine Construction (China).
For primary bibliographic entry see Field 8G.
W88-01444

8B. Hydraulics

COMPARISON OF PARALLEL CLARIFIERS WITH LEVEL AND NONLEVEL WEIRS,
Weyerhaeuser Co., Tacoma, WA.
For primary bibliographic entry see Field 5D.
W88-01031

INFLUENCE OF CONTINUOUS VERSUS CHANNELS ON MIXING CHARACTERISTICS AND PERFORMANCE OF ANAEROBIC DOWNFLOW STATIONARY FIXED FILM (DSFF) REACTORS BEFORE AND DURING WASTE TREATMENT,
National Research Council of Canada, Ottawa (Ontario). Div. of Biological Sciences.
For primary bibliographic entry see Field 5D.
W88-01033

EVALUATION OF FACTORS AFFECTING THE OXYGEN TRANSFER FROM HIGH-SPEED FLOATING SURFACE AERATORS,
Eastman Kodak Co., Rochester, NY.
For primary bibliographic entry see Field 5D.
W88-01053

HYDRODYNAMICS AND MODELING OF RE-REGULATION POOLS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 2H.
W88-01055

NORTH DIVERSION STRUCTURE ALBUQUERQUE, NEW MEXICO,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8A.
W88-01186

CHANNEL DEVELOPMENT IN THE LOWER REACH OF THE RED RIVER,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
J. E. Foster, C. R. O'Dell, and J. E. Glover.
Available from the National Technical Information Service, Springfield, VA. 22161. Hydraulic Model Investigation. Technical Report HL-87-9, MAy 1987. Final Report. 73 p, 16 fig, 2 tab, 26 plates.

Descriptors: *Channel improvement, *Red River, *Hydraulic models, Hydraulic structures, Navigation observations, Channel morphology, Channels.

The Red River Waterway provides for the development of a 9-ft-deep by 200-ft-wide navigation channel from Lake of Pines near Dangerfield, Texas, to Old River. The lower reach of the Red River with its flat slopes and narrow bends of short radii transverses the flood plain of the Mississippi River. A movable-bed model, reproducing about 4.7 miles of the Red River and a short section of the Black River to a horizontal scale of 1:120 and a vertical scale of 1:80, was used to provide an indication of the amount of maintenance dredging that would be required to: (a) maintain a navigation channel from Lock and Dam 1 to Old River; (b) develop a system of channel training structures to minimize the required dredging; and (c) determine the ultimate channel section to be expected in Lorran Lake cutoff, a cutoff proposed just upstream of the mouth of the Black River. The results of this investigation revealed: (1) The proposed overall channel was too wide to maintain a navigation channel of adequate width and depth above the Black River; (2) The development of an adequate navigation channel in the test reach would require a reduction in the width of the overall channel; (3) The first of the two plans proposed by the US Army Engineer District, New Orleans, Plan A, consisted of a 1.9-mile cutoff from mile 36.5 to 34.3 to increase the radius of the bend at the mouth of the Black River and the radius of the next bend upstream. Plan B was similar to Plan A in that it consisted of a cutoff channel in the same area; however, the cutoff channel from Plan B was 0.2 mile longer, and contained curves with radii at least 2,400 ft longer. Plan B, with its longer radius curves, would require less dike construction than Plan A to develop a navigation channel; (4) Structures would be required on the left bank downstream of the Black River to develop an adequate channel along an alignment suitable for navigation; and (5) Structures would be required on the downstream entrance to the old bendway to maintain an access channel into the old bendway for recreation. (Author's abstract)
W88-01187

SHELDRAKE RIVER TUNNEL, MAMARONECK, NEW YORK,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8A.
W88-01192

REGIONAL HYDROMETEOROLOGICAL ANALYSIS FOR SPILLWAY DESIGN,
Washington State Dept. of Ecology, Olympia.
M. G. Schaefer.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 523-530, 6 fig, 2 tab, 12 ref.

Descriptors: *Streamflow forecasting, *Probable maximum flow, *Hydrometeorology, *Spillways, *Hydraulic design, *Flow profiles, *Hydraulic properties, Guidelines, Risk assessment, Peak flow, Floods.

The development or revision of guidelines for the design of spillways for earthfill dams is a problem that is currently being faced by many regulatory agencies. Intuitive in any spillway design guideline is the concept of balancing the risk of under design with the consequences of a spillway failure. Unfortunately, existing guidelines rely heavily on engineering judgment and do not incorporate any actual risk assessment of spillway inadequacy in the decision-making process. A new approach to the problem of developing spillway guidelines is presented here, which utilizes a frequency analysis of extreme precipitation events for assessing risk. The analysis is accomplished from a regional perspective based on the concept that extreme storms can be more reliably analyzed on a regional rather than a point basis. The results of the analysis can be used in a risk based decision-making process for developing spillway design guidelines. This methodology should be especially attractive to regulatory agencies because it can provide information on the relative safety that a given design level will provide to projects in their region of jurisdiction. (See also W88-01203) (Author's abstract)
W88-01285

100-YEAR 24-HOUR EVENT: FACT OR FICTION,
HydroDynamics, Inc., Parker, CO.
For primary bibliographic entry see Field 2E.
W88-01286

DAM BREACH PARAMETERS, OUTFLOW PEAKS, AND FLOOD STAGES,
Illinois State Water Survey Div., Champaign.
K. P. Singh, and A. Snorrason.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 553-557, 2 fig, 1 tab, 7 ref.

Descriptors: *Hydrometeorology, *Flood routing, *Model studies, *Dam failure, *Flood waves, *Peak flow, *Floods, *Dam breach, Hydraulic properties, Outflow, Simulation analysis, Hydraulic flow, Structural behavior, Flood nurturing, Dams.

Important breach parameters were identified and their ranges estimated from a study of earth dam failures. The National Weather Service (NWS) and the U.S. Army Corps of Engineers Hydrologic Engineering Center (HEC) dam breach models were evaluated regarding their theoretical bases. Both models use similar input data and breach descriptions, but the NWS uses the St. Venant equations for routing, whereas the HEC uses hydrologic routing. Information on eight dams in Illinois was taken from the Corps of Engineers inspection reports. Various combinations of breach parameters (failure time, TF; depth of overtopping, H sub f; and breach size, B) were used for breach simulations by both methods with the 1.00-, 0.50-, and 0.25-PMF inflow hydrographs. The NWS

model performs better than the HEC model in simulating reasonable flood-stage profiles in the downstream reaches. The breach outflow peaks are affected significantly by B but less so by h sub f. The ratio of outflow peak to inflow peak and the effect of TF on outflows decrease as the drainage area above the dam and the storage impounded increase. For the range of breach parameters studied, the range of outflow peaks and flood stages downstream from the dam can be determined for regulatory and disaster prevention measures. (See also W88-01203) (Author's abstract)
W88-01290

SYNTHETIC UNIT-HYDROGRAPH PARAMETERS: DAM SAFETY PROGRAM,
Illinois State Water Survey Div., Champaign.
K. P. Singh.
IN: International Symposium on Hydrometeorology, June 13-17, 1982, Denver, Colorado. American Water Resources Association, 1983. p 571-576, 2 fig, 1 tab, 6 ref.

Descriptors: *Hydrometeorology, *Unit hydrographs, *Hazards, *Dam failure, *Dams, *Hydrographs, *Peak flow, *Flood peak, *Safety, Hydraulic properties, Stress, Hydraulic structures, Floods, Regression analysis.

The National Dam Inspection Act of 1972 authorized the Corps of Engineers to conduct hydrologic, hydraulic, structural, and geologic evaluations of dams with a high or significant hazard potential. Extensive precipitation and unit hydrograph analyses were conducted in the Illinois State Water Survey to help with the hydrologic evaluations. Four to six observed hydrographs for high floods and associated storm hyetographs for each of 131 basins were analyzed to develop unit hydrographs suitable for converting a 100-year rainfall excess to a 100-year flood hydrograph. Eleven unit-hydrograph parameters were evaluated: unit-hydrograph duration, peak, and time to peak; time to 0.25-, 0.50-, and 0.75-peak for both the rising and falling limbs of the unit hydrograph; time base; and a factor relating a small change in duration to the change in the peak. These parameters delineate a unit hydrograph very satisfactorily. The state was divided into eight homogeneous regions. The parameters in each region were regressed with easily measurable basin factors. The correlation coefficients were highly significant. (See also W88-01203) (Author's abstract)
W88-01293

PROCEEDINGS: CE WORKSHOP ON RESERVOIR RELEASES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 5G.
W88-01319

HOWARD A. HANSON RESERVOIR, WASHINGTON, TEMPERATURE ANALYSIS MATHEMATICAL MODEL INVESTIGATION,
For primary bibliographic entry see Field 5G.
W88-01328

ANALYSIS OF SEDIMENTARY SKELETAL DEFORMATION IN A CONFINED AQUIFER AND THE RESULTING DRAWDOWN,
Lawrence Livermore National Lab., CA.
For primary bibliographic entry see Field 2F.
W88-01346

AVERAGED REGIONAL LAND SUBSIDENCE EQUATIONS FOR ARTESIAN AQUIFERS,
Technion - Israel Inst. of Tech., Haifa.
For primary bibliographic entry see Field 6G.
W88-01347

8C. Hydraulic Machinery

RECENT DEVELOPMENTS IN TURBINE AERATION,
Tennessee Valley Authority, Norris. Engineering Lab.
For primary bibliographic entry see Field 5G.
W88-01337

8D. Soil Mechanics

WATER EFFECT ON CHANGE OF SHEAR RESISTANCE PARAMETERS OF WORKING MEDIA,
For primary bibliographic entry see Field 2G.
W88-01428

8E. Rock Mechanics and Geology

GENERAL GEOLOGY AND MINERAL RESOURCES OF THE CADDO RIVER WATERSHED,
Arkansas Geological Commission, Little Rock.
C. G. Stone, and W. V. Bush.
IN: Proceedings of the DeGray Lake Symposium, Technical Report E-87-4, March 1987. Final Report. p 10-55, 6 fig, 2 tab, 26 ref.

Descriptors: *Geology, *Minerals, *Caddo River, *Watersheds, Ouachita Mountains, Shale, Sandstone, Chert, Novaculite, Limestone, Erosion, Barite, Manganese, Rocks.

The Caddo River watershed is located in a picturesque area typified by jagged peaks, hogbacks, and broad rather hummocky basins comprising approximately 480 sq m (1240 sq km) in west-central Arkansas. It is located primarily in the Ouachita Mountains with a small portion in the Gulf Coast Plain. The exposed sedimentary bedrock in the Ouachita Mountain portions of the area is shale, sandstone, chert, novaculite, limestone, conglomerate, and tuff. These rocks are of deep-water marine origin and exceed 30,000 ft (9100 m) in thickness. They are of Paleozoic age ranging from Early Ordovician (about 490 million yrs) to Middle Pennsylvanian (about 290 million yrs). The Ouachita Mountains were formed when these rocks were uplifted by northerly directed compressive forces during late Paleozoic time. This deformation caused extensive thrust faults and complex fold systems. Some rocks were subjected to very low-rank metamorphism and related hydrothermal events as evidenced by locally pervasive shear planes, recrystallization, and numerous milky quart veins. Following the formation of the Ouachita Mountains there was a long period of erosion and minor arching with thousands of feet of rock being denudated from the area. In the southeast portions of the watershed the Paleozoic strata are overlain with a major unconformity by the slightly tilted mostly shallow-marine Late Cretaceous rocks. Covering the bedrock at places are unconsolidated, mostly flat-lying terrace, alluvial and colluvial deposits composed of clay, sand, gravel and cobbles of Quaternary age. Mineral resources are quite varied in the watershed with barite, manganese, rock aggregate, slate and quartz crystals comprising most of the past production. Numerous additional mineral resources could have economic potential. Surface and groundwater are very important resources in the watershed. (See also W88-01056) (Author's abstract)
W88-01057

GEOCHEMISTRY AND OCCURRENCE,
Midwest Research Inst., Kansas City, MO.
For primary bibliographic entry see Field 5B.
W88-01199

ELEMENTAL HYDROGEOLOGICAL CHARACTERISTICS OF COALFIELDS IN CHINA AND THE PROBLEMS OF PROTECTING AGAINST MINE WATER,
Institute of Geology and Exploration, Xian (China).
For primary bibliographic entry see Field 2F.
W88-01412

SIGNIFICANCE OF STRUCTUROLOGICAL INVESTIGATIONS IN DEFINING OF POSSIBLE DIRECTIONS OF INFLOW OF GROUND WATER INTO UNDERGROUND MINING WORKS,
Belgrade Univ. (Yugoslavia). Faculty of Mining and Geology.
V. Tomic, and N. Kresic.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 53-58, 4 fig, 4 ref.

Descriptors: *Mine drainage, *Coal mining, *Groundwater movement, *Geohydrology, *Geological surveys, Drainage, Jelovica coal mine, Serbia, Neotectonic analysis, Photogeological analysis, Graphical analysis.

The results of part of an investigation undertaken for the prognosis of possible directions of inflow of groundwater into the mining works of the Jelovica brown coal mine in eastern Serbia are presented. Among others, these investigations included neotectonic and photogeological analysis of fabric of the the terrain, as well as detailed structural investigations of water-bearing on numerous localities by empirical-graphoanalytical methods. All these investigations were performed without a detailed knowledge of geological features of the deposit, conditions of exploitation and results of other investigations (exploratory drilling, geological mapping, geophysical investigations, etc.). Unfortunately, the study serving as the basis for further development of the mine was not completed because a large quantity of groundwater burst into the underground mining works. (See also W88-01408) (Author's abstract)
W88-01413

ROLE OF POREWATER PRESSURE AND SEEPAGE FORCES ON THE STABILITY OF PROTECTION LAYERS,
Geoloski Zavod SRS, Ljubljana (Yugoslavia).
D. Kuscer, and M. Veselic.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 203-213, 4 fig, 5 ref.

Descriptors: *Coal mining, *Groundwater movement, *Geohydrology, *Stability analysis, *Pore pressure, Interstitial water, Seepage, Groundwater, Protection layer stability,Water pressure, Aquifers, Yugoslavia, Karst hydrology, Mine drainage, Mathematical equations, Mathematical studies.

During a study of water inrushes from karstified aquifers into coal mines in Slovenia (NW Yugoslavia), it was found that the determination of a safe thickness of the protection layer must take porewater pressure and seepage forces within the the protection layer into account. Two extreme aquifer models were considered when determining some factors influencing water inrush risks: (1) a rock with a perfectly homogeneous permeability which is approximated well in nature by a fractured dolomite, and (2) a channel in a permeable, fractured zone in an otherwise nearly impermeable rock as in a karstified limestone. The rocks between the mine working and the aquifer constituting the protection layer could not be considered impermeable since they always exhibit some intergranular porosity or are partly fractured; therefore, they are considered semipermeable. Mathematical equations are derived for the shearing strength of the protection layer when the rock masses are not subject to piping processes. The critical region for inrushes accompanied by piping processes was determined to be the wall of the mine workings and, therefore, appropriate equations were derived for the hydraulic gradient between the aquifer and the mine workings. Enhancing the stability of the protection layer with appropriate drainage of the protection layer was discussed briefly. (See also W88-01408) (Wood-PTT)
W88-01425

IMPORTANCE OF PROTECTION THE OPEN CASTS FROM UNDERGROUND AND SURFACE WATER CONCERNING SLOPE STABILITY ASPECTS,
For primary bibliographic entry see Field 2F.
W88-01426

ORIGIN AND PROCESS CONTROL OF WET ROCK MATERIAL INRUSHES,
Central Inst. for Mining Development, Budapest (Hungary).
Z. Keseru.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 255-267, 7 fig, 12 ref.

Descriptors: *Rock mechanics, *Wet rocks, *Mining engineering, *Rock movement, *Groundwater movement, *Semipermeable rocks, Clays, Case studies, Stress, Wet rock inrushes, Model studies, Safety, Rock properties.

Under stress conditions fissures or broken clay, marl, or semipermeable rocks penetrated by water may cause sudden rock movements; these dangerous rock-water interactions are called wet rock inrushes. Observations on inrushes and a simplified mechanical model of the phenomenon based on experiments were presented. Methods were given for forecasting hazardous wet rock material movement, based on the simultaneous study of four main interacting factors: (1) the possibility of water penetration, (2) the properties of the rock mass, (3) the stress conditions, and (4) the location of mine openings relative to the dangerous zones. Criteria were suggested for the selection of an appropriate control measure or combination of measures from among the most common, including protection against water penetration, control or modification of stress conditions, and construction of barriers between the zones of dangerous equilibrium and the mining operations. Several case studies are presented. (See also W88-01408) (Wood-PTT)
W88-01430

8F. Concrete

STRENGTH DESIGN OF REINFORCED CONCRETE HYDRAULIC STRUCTURES. REPORT 5: EXPERIMENTAL STUDY ON THE ULTIMATE BEHAVIOR OF MODEL REINFORCED CONCRETE CIRCULAR CONDUITS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.
For primary bibliographic entry see Field 8A.
W88-01188

DESIGN OF A PRECAST CONCRETE STAY-IN-PLACE FORMING SYSTEM FOR LOCK WALL REHABILITATION.
ABAM Engineers, Inc., Federal Way, WA.
For primary bibliographic entry see Field 8A.
W88-01407

8G. Materials

RESEARCH AND APPLICATION OF NEW GROUTING MATERIALS IN CHINA COAL INDUSTRY,
Beijing Research Inst. of Mine Construction (China).
Z. Chongrui.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 341-352, 7 fig, 1 tab.

Descriptors: *Grouting, *Grouting materials, *Coal mines, *Materials engineering, China, Cements, Organic compounds, Gels, Furfuraldehyde, Lignin, Chrome, Costs.

The results of research on, and the application of, new grouting materials for use in coal mines in China are presented. Applications for grouting technology are briefly reviewed with characteristics, advantages and limitations of available organic and inorganic grouting materials are outlined. Special mention is made of single liquid cement, cement clay, water-glass, CS double liquid cement, acrylamide, urea resin, furfuraldehyde and chrome lignin grouts. Use of cements for grouting has many advantages, including low price, wide availability, and no pollution, and is therefore deserving of continued research. Although the disadvantages of chemical grouting materials, which include high cost and pollution, limit their wide-spread application, they are necessary for solving difficult problems. More research is needed on this class of grouting materials in order to overcome the disadvantages and further the development of new grouting materials. (See also W88-01408) (Wood-PTT)
W88-01436

NEW DEVELOPMENTS IN THE FIELD OF GROUTING USING INTEGRATED METHOD,
STG Specialized Association, Antratsit (USSR).
E. J. Kipko.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 365-376, 2 fig, 1 tab, 3 ref.

Descriptors: *Grouting, *Materials engineering, *Mines, *Groundwater management, *Integrated Grouting Method, USSR, Case studies, Cracks, Geologic fractures, Water control, Groundwater, Karst, Cements.

Several examples from projects in the Donetsk and Moscow region coal mines which illustrate the high efficiency of the new process schemes for advanced grouting and rock consolidation based on the Integrated Grouting Method are presented. The new process schemes permit the formation of sealing curtains in large cracks and karstic zones, have significant advantages over the previous cement techniques, and can successfully replace expensive freezing techniques. They employ inexpensive and effective clay-cement grouts. The mine working conditions are safer and labor consumption is decreased since the volume of drilling is reduced, and grout preparation and injection are conducted from the surface. (See also W88-01408) (Wood-PTT)
W88-01438

ELIMINATION OF ABANDONED FLOODED WORKINGS DURING SHAFT SINKING AT YUZHNAYA MINE,
E. J. Kipko, V. A. Lagunov, and J. A. Polozov.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 377-383, 2 fig, 1 tab.

Descriptors: *Materials engineering, *Groundwater management, *Water control, *Grouting, *Coal mines, Yuzhnaya Mine, USSR, Nezhdannaya Mine, Abandoned mines, Flooding, Mine drainage, Geologic fractures.

During construction of new deep mines, the new vertical shafts sometimes must intersect abandoned mine workings which are often flooded because it is not economically feasible to pump them. Special procedures are required to protect the new shafts from strata water and to eliminate the possibility of failure to and damage of the mine shaft lining and equipment. Grouting methods using highly viscous plastic clay-cement grouts injected through long pipes by piston pumps were developed. The grout was effective both in small fissures with openings up to 0.1 mm and in large fissures and other underground voids. This grouting technique is characterized by high reliability, use of inexpensive and long-lasting grouts, and simple technology. The method was demonstrated in the USSR; upon completion of the grouting operations, the old workings of the Nezhdannaya Mine were flooded without damaging the shafts of the Yuzhnaya Mine. (See also W88-01408) (Wood-PTT)
W88-01439

RESEARCH OF GROUTING TECHNIC OF CONSOLIDATED SAND AND SEALING WATER BY A NEW CHEMICAL MATERIAL FOR WATER-DRAIN TUNNEL,
Northeast Coll. of Tech., Shenyang (China). Dept. of Mining Engineering.
L. Wu.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 385-394, 5 fig, 3 tab.

Descriptors: *Materials engineering, *Grouting, *Mine wastes, *Mine drainage, Metal mining, Metals, Water control, Groundwater management, Mathematical studies, Mathematical equations, Physical properties.

A 0.4 m thick water drainage tunnel located in the tailings pond of a metal mine was destroyed by soil pressure. A 25-180 mm wide circular fissure occurred in the tunnel which was covered with about 30 m of tailings. A large amount of water mixed with tailings poured into the tunnel and destroyed the water system used for ore dressing resulting in the disruption of ore production and economic losses. Tailings grains between 0.066 and 0.034 mm or less made up about 60.5% of the total weight. Because the groutability of the tailings was poor and the water still moving, a new chemical material was applied to form a firm grouting layer. It was shown that for tailings less than 0.066 mm, the new chemical grout was more effective, had higher mechanical strength, consolidated tailings more efficiently, and resisted acid and alkali permeability better than other chemical grouts. Physical properties of the new grout and grouting methods are detailed and theoretical grouting technology reviewed. (See also W88-01408) (Wood-PTT)
W88-01440

CONSOLIDATION OF TECTONIC RUPTURES USING CLAY-CEMENT GROUTS DURING TUNNEL DRIVING,
STG Specialized Association, Antratsit (USSR).
J. N. Spichak.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 403-410, 1 fig, 1 tab, 2 ref.

Descriptors: *Grouting, *Materials engineering, *Tunnel construction, *Tunneling, Groundwater management, Water control, Groundwater, Tunnels, Construction, Geologic fractures, Drainage, USSR, Severomuyski Tunnel.

Tectonic ruptures during multi-purpose tunneling through unstable aquiferous rock create difficulties for engineers. The basic principles behind a new consolidation technique involving the use of clay-cement grouts for water-bearing tectonic ruptures encountered during deep tunneling are explained. The grouting material was prepared and injected through boreholes using high-production equipment located at the surface. The applicability of this technique was discussed with regard to tectonic rupture size, strength of the ground, and depth of tunneling. The method was applied to the Severomuyski Tunnel in the USSR; the installation details and results are presented. The new technique was effective, efficient, and made use of inexpensive materials. (See also W88-01408) (Wood-PTT)
W88-01442

COMBINED SYSTEM OF SEALING A MINE UNDER HEAVY KARSTIC WATER HAZARD,
Central Inst. for Mining Development, Budapest (Hungary).
For primary bibliographic entry see Field 4B.
W88-01443

STUDY OF PRETREATMENT GROUTING TECHNOLOGY AT WORKING FACE IN AN AUXILIARY SHAFT OF HUANGHUAI COAL MINE,
Beijing Research Inst. of Mine Construction (China).
L. Xingpu, and S. Jiansen.
IN: Mine Water. Proceedings of the Second International Congress, Granada, Spain, September 1985. p 425-432, 3 fig, 1 tab.

Descriptors: *Grouting, *Materials engineering, *China, *Groundwater management, Glass, Water control, Coal mining, Huanghuai Coal Mine, Mine drainage, Drainage, Tunneling, Rock properties.

A pretreatment grouting technology used to enable the sinking of shafts in an unstable water-bearing stratum of the Huanghuai Coal Mine was explained. Water-glass was injected to form a thin film on the surface of the natural fractures. This acted as a lubricant for the particulate cement

grout by reducing flow resistance and increasing the quantity of cement injected. The water-glass has good permeability and increases the amount of cement which can be injected into loosened stratum. This in turn increases the consolidation efficiency and reinforcement range of the cement grout. Appropriate conditions under which this method is effective, detailed descriptions of the pretreatment material, and results in this particular case are given. In the Huanghuai Coal Mine the rock surrounding the shafts was consolidated, dehydrated and stabilized, and the water inflow was reduced by up to 86.2%. (See also W88-01408) (Wood-PTT)
W88-01444

8I. Fisheries Engineering

MODELING OF ULTRAFILTRATION FOR TREATING FISHERY WASTEWATERS,
North Carolina State Univ., Raleigh. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W88-01022

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Fish and Wildlife Service, Fort Collins, CO.
For primary bibliographic entry see Field 2E.
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FISH, PATHOGENS AND ENVIRONMENT IN EUROPEAN POLYCULTURE.
For primary bibliographic entry see Field 5C.
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RELATIONSHIP OF WATER QUALITY AND INFECTIOUS DISEASES IN CULTURED CHANNEL CATFISH,
Alabama Agricultural Experiment Station, Auburn.
For primary bibliographic entry see Field 5C.
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EFFECT OF NH3 ON BLOOD GLUCOSE AND CATECHOLAMINE LEVEL, GOT, GPT, LDH ENZYME ACTIVITY AND RESPIRATION OF FISHES,
Jozsef Attila Univ., Szeged (Hungary). Dept. of Biochemistry.
For primary bibliographic entry see Field 5C.
W88-01497

HISTOPATHOLOGICAL DIFFERENTIAL DIAGNOSIS OF GILL CHANGES WITH SPECIAL REGARD TO GILL NECROSIS,
Orszagos Allategeszsegugyi Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 2H.
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